



Research Product 93-02

**Description of a Tank-Based Automated
Command and Control System
as Simulated for the Combat Vehicle
Command and Control Program**

February 1993

**Fort Knox Field Unit
Training Systems Research Division**

U.S. Army Research Institute for the Behavioral and Social Sciences

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AD A 263459

U.S. ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES

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REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
<small>Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.</small>				
1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE 1993, February		3. REPORT TYPE AND DATES COVERED Final Sep 90 - Jul 92
4. TITLE AND SUBTITLE Description of a Tank-Based Automated Command and Control System as Simulated for the Combat Vehicle Command and Control Program			5. FUNDING NUMBERS DAHC35-89-D-0044 63007A 795 3101 C09	
6. AUTHOR(S) LaVine, Nils D. (MA&D); Lickteig, Carl W. (ARI); Schmidt, Jeffrey H. (University of Louisville)				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Micro Analysis & Design Inc. 3300 Mitchell Lane, Suite 175 Boulder, CO 80301			8. PERFORMING ORGANIZATION REPORT NUMBER --	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Research Institute for the Behavioral and Social Sciences ATTN: PERI-IK 5001 Eisenhower Avenue Alexandria, VA 22333-5600			10. SPONSORING / MONITORING AGENCY REPORT NUMBER ARI Research Product 93-02	
11. SUPPLEMENTARY NOTES Contracting Officer's Representative, Kathleen A. Quinkert.				
12a. DISTRIBUTION AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.			12b. DISTRIBUTION CODE --	
13. ABSTRACT (Maximum 200 words) This research product describes an automated command and control system developed for simulation-based assessment in the Close Combat Test Bed (CCTB) at Fort Knox. This tank-based system reflects many of the user-interface requirements identified during the course of the U.S. Army Research Institute for the Behavioral and Social Sciences' efforts in support of the Combat Vehicle Command and Control (CVCC) program. The system described was used to conduct the CVCC preliminary battalion-level evaluation during January-June 1991. Description of this user-based system may help to ensure its consideration in the Army's development efforts.				
14. SUBJECT TERMS Human performance Close Combat Test Bed (CCTB) Command, Control, and Communication (C ³)			15. NUMBER OF PAGES 75	
			16. PRICE CODE --	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT Unlimited	

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Control Program**

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Department of the Army

February 1993

Army Project Number
2Q263007A795

Training Simulation

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FOREWORD

The U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) conducts research on human performance and training. The ARI Field Unit at Fort Knox maintains a leading role in the use of soldier-in-the-loop network simulation to address these issues, particularly in the area of automated command and control systems for future ground combat vehicles. A key factor in the development of automated command and control systems is the user-based assessment of candidate systems.

This research product describes a Command and Control Display (CCD) used in ARI's preliminary battalion-level evaluation of the Combat Vehicle Command and Control (CVCC) system. This work was conducted under the Science and Technology task entitled "Training Requirements for the Future Integrated Battlefield" with funding from the Combat Vehicle Command and Control program sponsored by the Tank Automotive Command (TACOM). This effort is supported by ARI's memorandum of agreement (MOA) with the United States Army Armor Center (USAARMC), entitled "Research in Future Battlefield Conditions" and signed on 12 April 1989, and ARI's MOA with TACOM on the Combat Vehicle Command and Control System, 22 March 1989.

The ARI Field Unit at Fort Knox has conducted a series of simulation-based evaluations on automated command and control systems with participant vehicle and unit commanders at all tank battalion echelons. Lessons learned from these evaluations modified the system's design and resulted in the CCD described herein. The objective of this research product is to ensure that a description of the CCD's user-based design is available for Army consideration in its development efforts. Results of this effort were provided to TACOM's Vetronics Division, the Director of Combat Developments (DCD) at Fort Knox, the Director of the Mounted Warfighting Battlespace Laboratory, and the Program Manager for Common Chassis.



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DESCRIPTION OF A TANK-BASED AUTOMATED COMMAND AND CONTROL SYSTEM AS SIMULATED FOR THE COMBAT VEHICLE COMMAND AND CONTROL PROGRAM

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DESCRIPTION OF A TANK-BASED AUTOMATED COMMAND AND CONTROL SYSTEM AS SIMULATED FOR THE COMBAT VEHICLE COMMAND AND CONTROL PROGRAM

Introduction

The U.S. Army is developing advanced command and control (C²) capabilities for ground combat vehicles. In support of this effort, the Army Research Institute at Fort Knox is currently involved in a research and development program on future Combat Vehicle Command and Control (CVCC) systems under the sponsorship of the Tank Automotive Command (TACOM). As part of the CVCC program, ARI conducts soldier-in-the-loop research on future C² training requirements using the Armor Center's Close Combat Test Bed (CCTB) at Fort Knox.

This product describes the tank-based Command and Control Display (CCD) developed for evaluation on the CCTB's simulated battlefield. The CCD is the primary component of the CVCC system. This CCD description is based on version CVCC 6.12 software used in ARI's preliminary battalion evaluation of automated command and control systems conducted in the CCTB from January-June, 1991.

The CCD's design reflects many of the user requirements identified in the course of ARI's research program on vehicle-based automated command and control systems. The objective of this product is to provide a detailed description of the CCD's design to help ensure its consideration in the Army's future development efforts.

This product is organized in three sections. This first section briefly reviews the Army's requirement for tank-based C² systems, ARI-Knox's role in support of this requirement, and the CVCC system as simulated in the CCTB. This section concludes with a short description of how the CCD may assist armored unit and vehicle commanders during combat operations.

The primary section, the Description of the Command and Control Display, begins with an overview that includes the CCD's map and report functions, input devices, and menu structure. This overview is followed by a detailed description of each function provided by the CCD in conjunction with the display screens the commander accesses and completes to use each function.

The final section summarizes anticipated CCD modifications and illustrates the "test and fix" approach employed in the CVCC program. Anticipated modifications are included in this product to provide a more complete description of the system evolving from this ongoing CVCC effort.

Army Requirement

The Army's current focus on precision warfare, the nonlinear battlefield, multinational contingency operations, and reduced forces only underscores its long-standing requirement for advanced C² capabilities (Foss, 1991). The Army's increasing reliance on combined arms operations requires that its investment in Army Tactical Command and Control Systems (ATCCS) is realized at the forward edge of the battlefield where vehicle-based commanders operate. Automated C² systems, however, may deluge front-line commanders in a flood of information if these systems are not developed and tested to meet the requirements of each command level and commanders are not sufficiently trained to use these systems (Burkett, 1991; Foley, 1991; Giboney, 1991).

An operational concept for vehicle-based automated C² systems in the near term was recently defined by Armor's Directorate of Combat Developments (DCD) (U.S. Armor School, 1992). The concept states that these systems must speed up the plans-orders cycle; enhance lethality through decisive maneuver and the coordination of combat power and indirect fires; improve survivability by distributing forces while massing direct and indirect fires; enhance situational awareness by depicting friendly locations and enemy targets without recourse to voice communications; and reduce fratricide through knowledge of friendly locations (U.S. Armor School, 1992).

Armor's requirement for automated C² systems promoted the establishment of the CVCC program in 1988. A primary objective of this bilateral (German-U.S.) research and development program is to develop through testing a specification for vehicle-based automated C² systems (Bolte, Black, & Mendel, 1991). Such systems are expected to support allied operations on the future battlefield by providing battalion-and-below vehicle commanders an integrated weapon system that enables decisive maneuver, hunter-killer engagement, and graphic depiction of the battlefield situation. Within and across units, CVCC's digital network will enhance unit commanders' ability to synchronize plans, coordinate mission preparation, and directly monitor mission execution.

Simulation-Based Evaluations

With the advent of SIMulation NETworking (SIMNET) technology (Miller & Chung, 1987; Pope, 1987) at Fort Knox, a test bed for soldier-in-the-loop assessment of developmental systems was soon established in the CCTB (Alluisi, 1991). Simulators in the CCTB serve as reconfigurable weapon systems that emulate the features, capabilities, and soldier-machine interfaces of developmental systems. Currently, eight (8) M1 tank simulators in the CCTB are configured with CVCC systems.

The CCD design for the CVCC simulators originated from a preliminary concept developed by the Armor School's DCD and

ARI-Knox (Blasche and Lickteig, 1984). A stand-alone, computer-based model of this command and control system was used to identify user-interface requirements (Lickteig, 1986). Guided by these requirements, a system description (U.S. Armor School, 1988) and specification (Lickteig, 1988) directed the development of an interactive C² system for soldier-in-the-loop assessment in the CCTB.

Working from this initial design, ARI-Knox conducted a series--from individual tank to battalion--of automated C² system evaluations in the CCTB. During each evaluation, user requirements for automated C² systems were obtained through commander and crew debriefs, structured questionnaires, after-action reviews, and performance measurement. The procedures for obtaining user requirements, the "lessons learned" during operational testing, and the rationales for the CCD design as described herein are documented for each evaluation (Ainslie et al. 1991; Du Bois & Smith, 1989 and 1991; O'Brien et al. 1992). Given the lessons learned during this series of soldier-in-the-loop evaluations, the design of the CCD has evolved in an effort to meet the user requirements identified.

Combat Vehicle Command and Control Component Integration

CVCC system modifications to a future tank impact the stations and duty requirements for all four crew members: tank commander, gunner, loader, and driver. As this description focuses on the CCD, the impact of the CCD on the commander's station and performance is stressed as CVCC components and their integration with the CCD are described. More complete descriptions of the overall CVCC system and its configuration for soldier-in-the-loop assessment are available (Ainslie, Leibrecht, & Kerins, 1991; Leibrecht et al. 1992; O'Brien et al. 1992).

The CVCC system in the CCTB tank simulator is comprised of six primary components: the CCD, the Commander's Independent Thermal Viewer (CITV), the Position Navigation (POSNAV) system, the Single Channel Ground and Airborne Radio System (SINCGARS), the autoloader, and the driver's Steer-to-Indicator (STI).

Within the simulated tank turret, the general layout of the CVCC-equipped commander's station is presented in Figure 1. In this figure, the commander is making inputs on the CITV with the CCD positioned directly to his right. The commander's interface to POSNAV is integrated in the CCD's display and controls. Although not shown in Figure 1, the simulated SINCGARS and autoloader are located to the left of the commander in the loader's station. The STI is located in the driver's station.

For an initial overview of the CCD, Figure 2 depicts this display in a sample operational mode that illustrates the tactical map's digitized terrain and overlay, friendly-vehicle and enemy-report icons, and a preformatted Spot report.

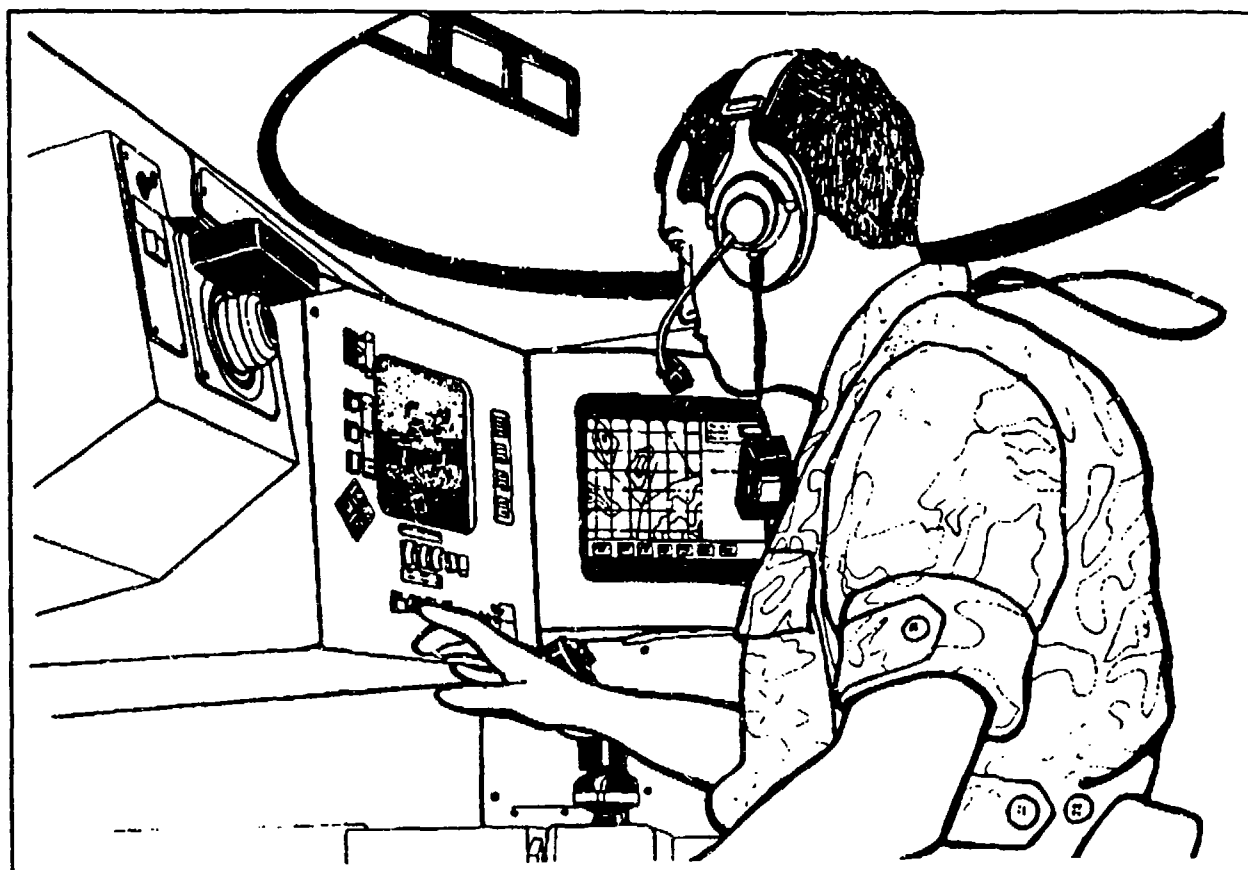


Figure 1. Layout of Combat Vehicle Command and Control commander's station (commander touching the Commander's Independent Thermal Viewer with the Command and Control Display to his right).

The CITV, shown in Figure 3, provides the commander with a thermal view of the battlefield independent of the gunner's thermal sight (Quinkert, 1988). It allows the commander to independently acquire and directly hand-off targets to his gunner. This CITV hunter-killer allocation of tasks enhances the lethality of the CVCC weapon system (Quinkert, 1990).

Outputs from the Laser Range Finders (LRF) in the CITV and main gun, combined with POSNAV data, provide target location inputs directly to the CCD. This capability is referred to as far-target designation. As a target is lased, the CCD depicts this enemy's icon on the tactical map and inputs the target's grid location in a CCD enemy-report format.

The CITV provides its direction and sector scan information to update the own-vehicle icon on the CITV and its directional information to update the own-vehicle icon on the CCD's tactical map. These CITV updates assist the commander in maintaining orientation on the battlefield, particularly during engagement phases (Fisicaro & Quinkert (1989)).

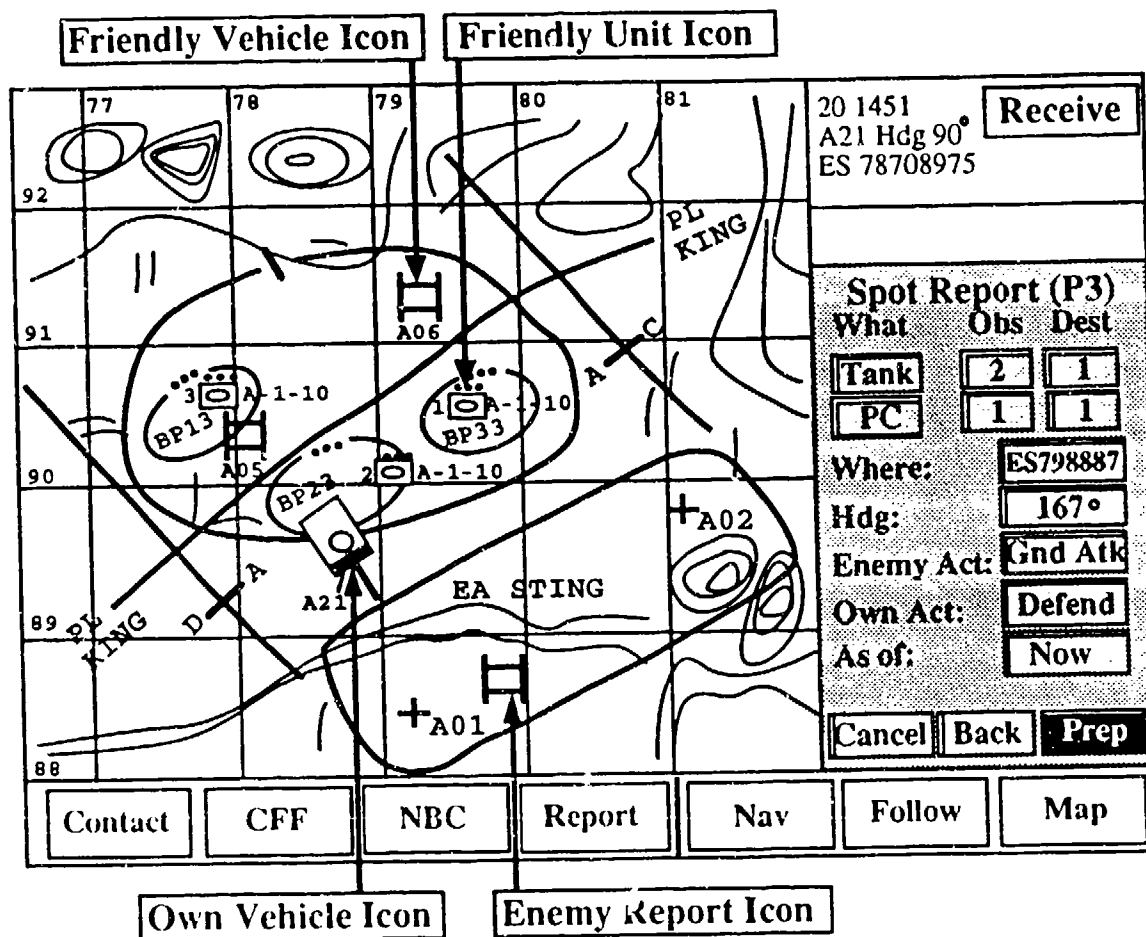


Figure 2. Command and Control Display in operational mode.

POSNAV, a key component of the CVCC system, supplies current location and heading data on the commander's vehicle to the CCD in analog (icon) and digital format (Figure 2). As noted, POSNAV outputs on own-vehicle position and heading data combined with distance and azimuth inputs from the LRFs enable the far-target designation capability.

POSNAV's integration with the CCD's tactical map allows the commander to designate vehicle and unit routes by simply selecting waypoint locations on a digital map of the operational area. Based on the route entered, the CCD can generate direction and distance information on the STI to assist the driver in navigating to each route waypoint. In addition, these vehicle or unit routes can be transmitted over SINCGARS to other CVCC-equipped commanders to synchronize maneuver for enhanced command and control.

POSNAV own-vehicle location updates are transmitted automatically over SINCGARS to enable the exchange of friendly vehicle and unit locations between CVCC-equipped vehicles. This mutual POSNAV information is displayed by the CCD as

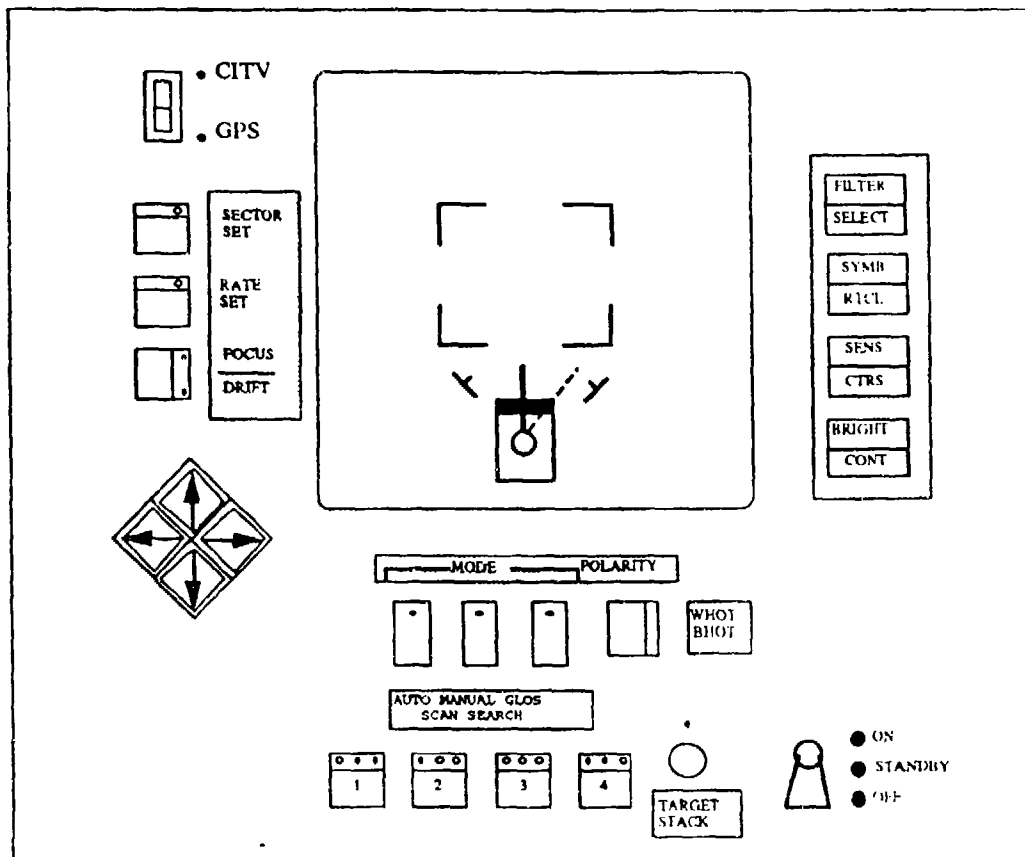


Figure 3. Commander's Independent Thermal Viewer.

friendly vehicle and unit icons on the CCD's tactical map (see Figure 2).

Simulated SINGARS radios in each tank simulator provide a digital network that links front-line commanders with rear-echelon units and staffs throughout the planning, preparation, and execution phases of combat. SINGARS transmits both voice and CCD-based reports and graphics, with voice precedence.

SINGARS transmission of operational overlays combined with their depiction on the CCD's tactical map is expected to greatly enhance a combat unit's ability to disseminate, coordinate, and understand the commander's concept of the operations. A display that accurately generates real-time friendly vehicle locations and operational graphics on a tactical map should improve the commander's ability to monitor, command, and control mission execution.

SINGARS' message packets include message transmission times and call signs for sender identification. This radio's burst communication and frequency hopping is expected to significantly reduce, or eliminate, time-consuming and error-prone security procedures such as authentication and encryption.

Coupled with a Radio Interface Unit (RIU), the SINCGARS transmits selected communications such as position updates from POSNAV without commander intervention. Duplicate reports are eliminated automatically upon reception to reduce information redundancy. Although not currently simulated, the RIU can monitor message reception and retransmit messages as required through alternate communication links.

The autoloader performs many of the loading duties of the loader crew member. With the addition of the autoloader, the crew size of the CVCC-equipped tank simulator is reduced from four to three. The autoloader tracks main gun round expenditures and provides this information to CCD-based ammunition status reports. This process partially automates logistics reporting by the commander.

Outside the simulated turret, the STI in the driver's station should allow the driver to navigate a route more independently. The simulated STI sits below the driver's right vision block (Figure 4). Information provided on this display includes the current waypoint number, distance to the waypoint, vehicle heading, deviation between vehicle and waypoint headings, and an indicator showing the steer-to direction to the current waypoint. The STI is a read-only display, the driver cannot alter information received from the commander.

Systems Integration

CVCC components must be linked with numerous onboard tank components to achieve a fully-integrated weapon system. For CCTB implementation, only simulation of information exchanges between CVCC components and simulated tank components is required. For example, simulated fire control system inputs are used to generate the range to a distant point and the location of the main gun with respect to hull orientation. Simulated outputs anticipated from integration of the autoloader with the hull/turret networks box provide CCD inputs on main gun expenditure to partially automate reports on ammunition supply status.

CVCC-equipped vehicles must eventually be linked to ATCCS to realize the digitized battlefield envisioned for the Army. For CCTB implementation, simulator-based CCDs are networked together for intervehicular communication and networked to automated C² stations in the battalion Tactical Operations Center (TOC). Currently, this TOC includes three (3) stations that support Operations, Intelligence, and a large-scale situation map of the battlefield. In turn, these TOC stations are linked to simulated brigade-level C² functions in the exercise control room to complete the digital networks used during CVCC battalion-level evaluations (O'Brien et al. 1992).

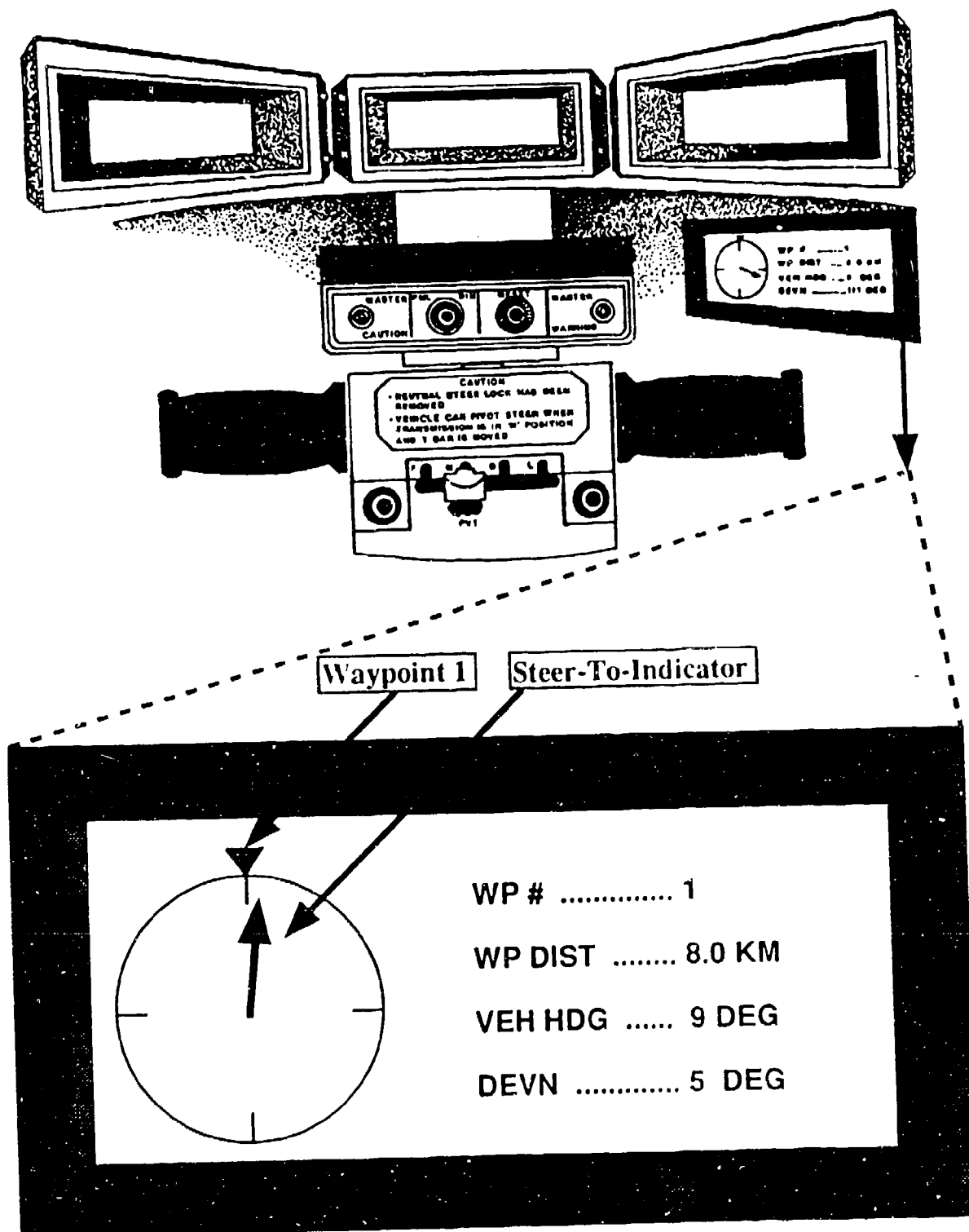


Figure 4. Layout of Combat Vehicle Command and Control driver's station (with Steer-To-Indicator enlarged).

System Utilization

The Armor Center's operational concept for vehicle-based automated C² systems clearly identifies their potential for improving command and control performance while acknowledging their profound impact on command and control procedures (U.S. Armor School, 1992). It describes in detail how this tool might be used by commanders at each battalion echelon in the conduct of combat operations. In comparison, the following synopsis only highlights the potential utilization of a system such as the CCD.

During the planning and preparation stages of an operation, the CCD is expected to provide vehicle-based unit commanders an unprecedented capability to receive, in an armored setting, digital copies of operational graphics and orders. Early and accurate reception of this information may clarify the commander's intent and provide subordinate commanders additional time to prepare their unit and coordinate with lateral units.

During the earliest phases of execution, commanders may monitor the movement of the entire force on the CCD's tactical map. Thus, unit commanders may more readily detect required adjustments in unit speed, location, and formation to synchronize maneuver. The recurring requirement for the difficult and time-consuming tasks of terrain-association and location determination should be greatly reduced, particularly under low visibility conditions. The persistent requests for and communications on location and situation updates should be reduced or, in some cases, completely eliminated. For example, commanders can observe on the CCD many of the maneuver events currently reported over voice radio such as "Crossing Phase Line King."

During contact, vehicle commanders will be drawn to the fight and the battlefield, and away from their C² displays. When enemy units are in line-of-sight, acquisition and destruction by direct view optics is paramount. While voice is a powerful and synchronous mode for communicating during contact, automated systems may assist with capabilities such as far-target designation into Contact and Call For Fire reports. Such designations generate accurate and succinct combat report data that can be relayed quickly over multiple combat radio nets. At the same time, unit commanders may rely on the CCD's depiction of their unit and reported enemy units to develop or exploit the battlefield situation.

During consolidation, automated logistics reporting should significantly reduce the effort and time required to assess the unit's operational readiness. Proactive resupply should ensue with automated status data and verified vehicle locations. Meanwhile, commanders may more confidently plan and decide subsequent actions with an enhanced awareness of their unit's disposition and the enemy's situation. Fragmentary orders and overlays detailing these plans can be developed and digitally disseminated to reinitialize combat operations rapidly.

Transition to more automated C² systems involves many trade-offs and the potential for increased workload and decreased information. In a workload assessment of the CCD, for example, commanders stated that the CCD increased their workload for tasks such as preparing Contact, Call For Fire, and Spot reports (Morey, Wigginton & O'Brien, 1992). Errors associated with net selection on the CCD for report transmission suggest that auditory cues in voice-based systems may reinforce information source and distribution requirements (Emery and Lickteig, (1991)).

A primary CVCC objective is to allow the user to examine such trade-offs before an automated C² system is fielded. User-based evaluations and modifications may eliminate some potential trade-offs and initiate the development of standard operating procedures to increase system utility. Ideally, an automated C² system is a "tool" crafted by its users and wielded to their advantage.

Description of the Command and Control Display

All CCD functions described in this section pertain to the simulation-based functions available in the CCTB under CVCC software version 6.12. This software version was used in ARI's preliminary battalion evaluation conducted in the CCTB from January-June 1991 (O'Brien et al. 1992).

The CCD integrates information exchanges among CVCC components and serves as the soldier-machine interface to all CCD functions and features, see Table 1. This section begins with an overview on the CCD's layout, map and report functions, input devices, and menu structure. After this description of general CCD features and characteristics, a detailed description of each CCD function is provided in conjunction with the display screens the commander accesses and completes to use each function.

Layout of the Command and Control Display

In the CVCC tank simulators, the CCDs are mounted to the right of the commander's weapon station as depicted in Figure 1. CCD functionality including the digital terrain data base is hosted in a MASSCOMP 5600 computer. The CCD is projected on a 13-inch (33 cm), color, cathode ray tube (CRT) monitor with high resolution (1,250 X 1,024) and a touch-sensitive screen. The display itself occupies a rectangular region (7 X 5.75 inch, 17.8 X 14.6 cm) in the lower right corner of the CRT monitor reflecting the space-claim projected for vehicle implementation in an Abrams tank.

As illustrated in Figure 5, the CCD interface is partitioned into five separate windows or sections: Tactical Map, Vehicle Information, Status/Alert, Variable Menu, and Dedicated Keys. These five windows are dedicated areas with permanent spatial allocations on the CCD interface.

Table 1

Features of the Command and Control Display

- Digitized terrain map
- Map scale, scroll, and feature manipulation
- Own-vehicle location and heading (analog and digital format)
- Friendly locations at vehicle or unit level
- Route designation
- Route transmission
- Driver's Steer-to-Indicator (STI) inputs
- Waypoint autoadvance to STI
- Digital report preparation
- Far-target designation for map-based inputs
- Report icons and icon-based report retrieval
- Digital report transmission, reception, and relay
- Digital overlay transmission, reception, and relay

The Tactical Map window displays a digitized map of the area and all icons and control measures generated by CCD-based reports, overlays, and POSNAV updates. The Vehicle Information window provides the current date/time group, the commander's call sign, and the vehicles current heading and location. The Status/Alert window displays messages created by the CCD when a function is performed such as "Message Sent" or when delays occur in system response such as "Map Rescaling."

The Variable Menu window provides the menus required for report reception and preparation, route designation, and map manipulation. Variable refers to the different menus or screens that are called to this window as CCD functions are accessed and used. Dedicated keys are used to access all functions of the CCD. Seven of these eight keys are located along the bottom of the display in the Dedicated Keys window. An eighth dedicated key, labeled Receive, is located in the Vehicle Information window.

Tactical Map and Map Manipulation

The tactical map on the CCD is generated from a CCTB digital-terrain data base and displayed in a North-up orientation. The map display is generally consistent with military paper maps (Department of Army, 1988). For example, the tactical map displays land contour, rivers, roads, vegetation, and map grid lines in their respective military map colors: brown, blue, red, green, and black. Friendly units appear in blue, friendly graphic control measures appear in black, and enemy units and control measures appear in red.

Standard military map scales available on the CCD are 1:25,000, 1:50,000, and 1:250,000. A non-standard scale of

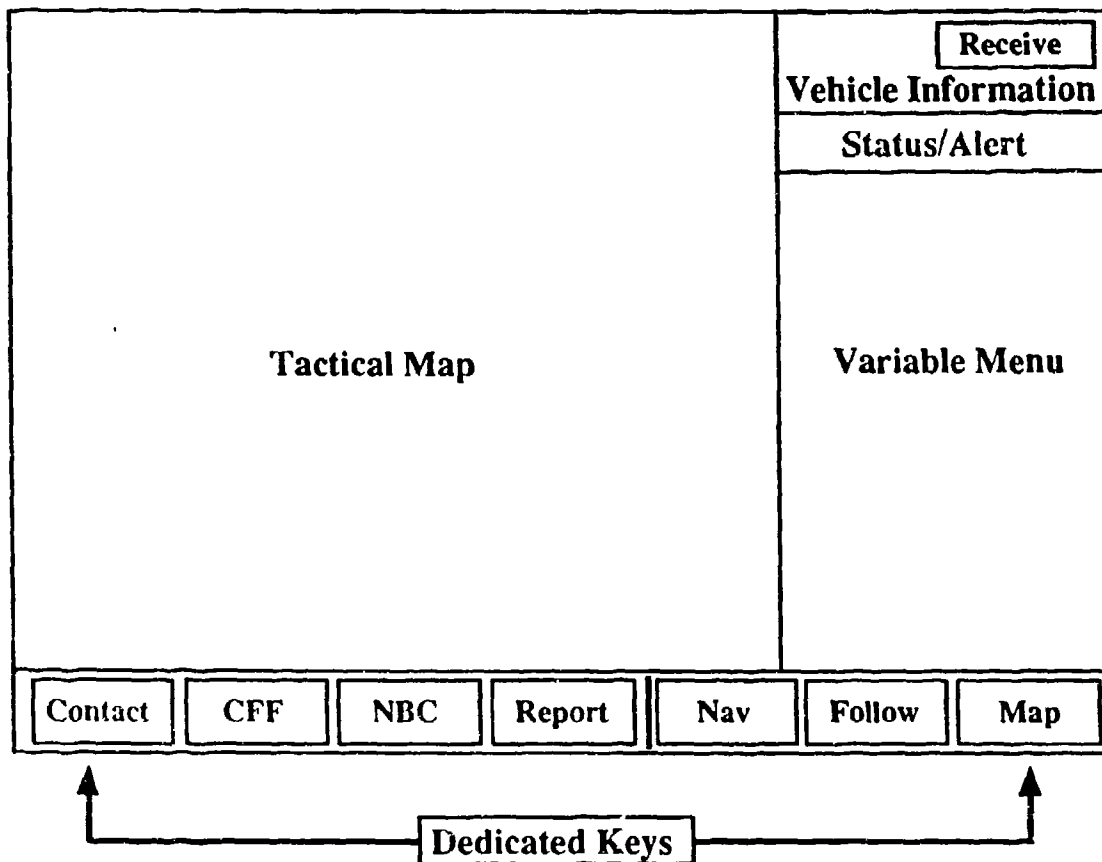


Figure 5. Layout of Command and Control Display (Receive key in upper right of the display is also a dedicated key.).

1:125,000 is also available to provide an intermediate map area. Given the limited display size on the CCD's tactical map, the area depicted at successive scales is approximately: 3-, 6-, 15-, and 30-square kilometers. To reduce map clutter, grid lines separate each kilometer at the two higher scales, every five kilometers at 1:125,000, and every 10 kilometers at 1:250,000. Control measures, for directing combat operations, rescale automatically with changes in map scale.

On the tactical map, the own-vehicle icon provides the commander a graphic depiction of his tank's location and the orientation of its hull, main gun, and CITV (see Figure 2). The own-vehicle icon is distinctly larger than other vehicle or report icons and the commander's call sign is displayed below it. The identity and location of other CVCC-equipped friendly vehicles are updated on the tactical map based on the CCD's ability to exchange POSNAV information. The commander can display these other friendly icons at either vehicle or unit level.

Map movement on the CCD is conducted in several ways. In the default mode, the map scrolls automatically beneath the

commander's own-vehicle icon as the simulator moves across the map data base. In this default mode, the own-vehicle icon is continuously located in the center of the map area displayed.

The commander can also reposition, off-center, his vehicle icon and still retain the scrolling map capability. For example, he might move his vehicle icon to the lower edge of the map window to view more of the forward battlefield area during conduct of an offensive operation to the North. As such, his vehicle icon remains at the lower border of the map display as the map scrolls to update his movement North.

In addition, the CCD provides a dedicated function to allow the commander to scroll the map manually to view or access other map areas temporarily. For instance, he may need to designate a series of route waypoints beyond the map area displayed. This dedicated scroll capability should reduce the commander's need to access overlapping, map-manipulation menus while performing a task such as route designation. If the own-vehicle icon disappears from the area displayed while scrolling the map, a blue arrowhead-shaped symbol appears at the map's perimeter to indicate direction to the own vehicle icon.

Map-Based Report Icons

A set of report icons, shown in Figure 6, is used to portray map-based information from prepared and received CCD reports. This set of icons is used for both friendly (blue) and enemy (red) depiction. Report icons are displayed on the tactical map as soon as an incoming report is received by the CCD or the commander designates an icon's location on the map during preparation of a CCD-based report.

All report-based icons provide a link to their associated reports. Using icon retrieval, the commander's selection of a report icon highlights that icon on the tactical map and its associated message header in the Variable Menu window. In turn, selection of a message header highlights that header and its report icons.

If a report icon is placed directly on top of other report icons, they become "stacked" by age. The most recent icon is placed on the top of the stack and older icons are moved to the bottom. A white box appears around the icons to indicate they are stacked. After selecting a stack, the commander can move through it by selecting it a second time. Successive selection of the same stack places the top icon on the bottom and brings the next one to the top.

Due to the limited viewing area of the map window, report and own-vehicle icons are not always present on the map area currently displayed. The CCD is designed to indicate where such off-display icons are located. For a report icon not currently visible, an arrowhead-shaped symbol at the map's perimeter



Tank

Used in CFF, Contact, Intelligence (Enemy and Friendly), and Spot reports.



Helo

Used in CFF, Contact, Intelligence (Enemy and Friendly), and Spot reports.



Arty

Used in CFF, Contact, Intelligence (Enemy and Friendly), and Spot reports.



FW Air

Used in CFF, Contact, Intelligence (Enemy and Friendly), and Spot reports.



Truck

Used in CFF, Contact, Intelligence and Spot reports.



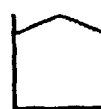
Troops

Used in CFF, Contact, Intelligence and Spot reports.



ATGM

Used in CFF, Contact, Intelligence and Spot reports.



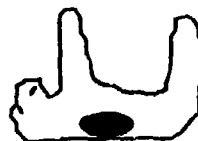
PC

Used in CFF, Contact, Intelligence and Spot reports.



Nuclear

Used in NBC reports.



Biological

Used in NBC reports.



Chemical

Used in NBC reports.



Observer's Location

Used in NBC reports.



Misc

Used in Intelligence (C2, Mech, Mortar, Scout, Support, and obstacles), Shell, Situation, and Adjust fire reports.

Figure 6. Report icons for the Command and Control Display (CFF = Call For Fire, Arty = Artillery, ATGM = Anti-Tank Guided Missile, NBC = Nuclear, Biological, and Chemical, Misc = Miscellaneous, C2 = Command and Control, Mech = Mechanized, Helo = Helicopter, FW Air = Fixed Wing Aircraft, PC = Personnel Carrier).

indicates the direction the map needs to be moved to view this icon. These arrowhead indicators appear as red or blue to indicate enemy or friendly information.

Input Devices and Procedures

The CCD provides redundant input devices including a touch-sensitive screen, the thumb-cursor control on the commander's override (shown in Figure 7), the gunner's LRF, and the CITV's LRF. User inputs are map-based location and heading data or menu-based options. Except for LRF map-based inputs, all other CCD inputs are made from the windows titled Tactical Map, Variable Menu, and Dedicated Keys or the dedicated key labelled Receive.

The CCD cursor for the touch screen and thumb control is an opaque plus sign (+). For touch inputs, the position of the cursor is offset above the point at which the commander touches the screen to allow an unobstructed view of where the cursor is located. Cursor location for touch inputs is based on the pointing object's center of mass to enable input even when wearing cold weather or contamination gloves. Alignment of the cursor on a key or menu entry highlights the item to prompt selection. Selections are activated upon release of the finger from the touch screen or the thumb from the cursor control in an effort to reduce input errors, particularly on a moving weapon system.

For map-based inputs such as the location of a report icon or route waypoint, the commander can enter a map location using the touch or thumb cursor by merely selecting a terrain point on the tactical map. The LRFs can also be used to input these map-based locations. All location inputs are automatically converted by the CCD into a six-digit Universal Transverse Mercator (UTM) grid coordinate (e.g. ES123456) and entered in a menu-based field.

All menu-based options are preformatted and limited by the area available in the Variable Menu window. Version 6.12 software does not provide a numeric key pad. Numeric options for all CCD reports are based on subject-matter-expert estimates of the most probable response options for each type of field.

As each menu screen is accessed, the CCD activates the first menu fields that are available for input. If a menu includes both map- and menu-based inputs, the first map and menu fields are activated automatically since their inputs are made from the Tactical Map and Variable Menu, respectively. Menu fields can generally be completed in any order. Fields are not mandatory, the commander determines which fields to complete.

As each menu screen is accessed, the input options are listed automatically for the activated menu-based field. When the commander selects one of these options, the CCD activates the

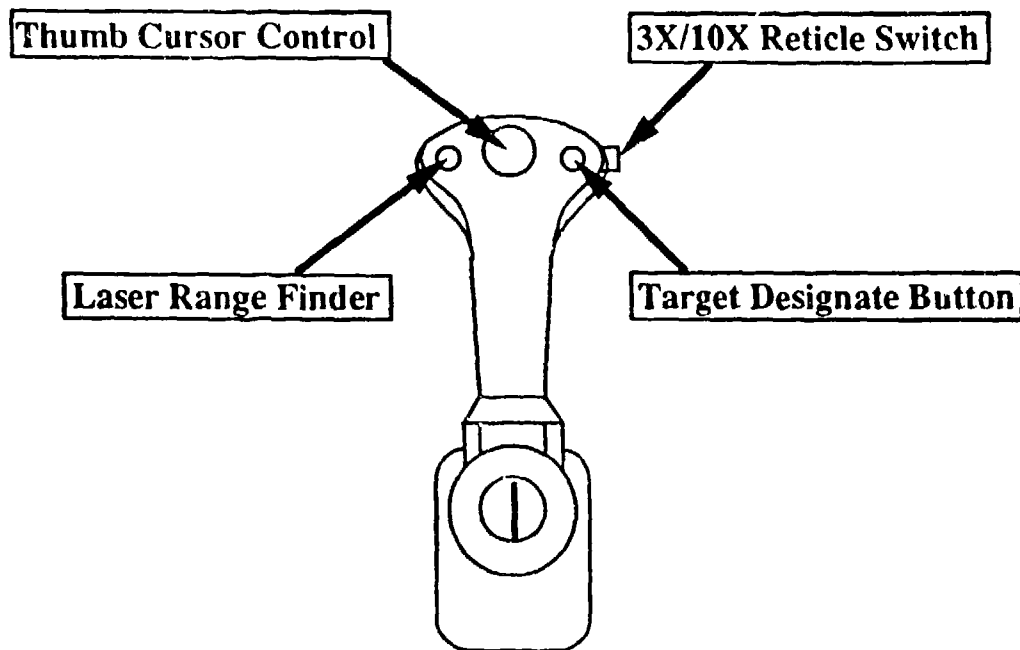


Figure 7. Commander's override handle with thumb cursor control.

next menu-based field on this menu and displays its options. For map-based inputs, however, the CCD does not activate the next map-based field after entry in a similar field. To allow the commander to adjust the current map-based entry, if needed, the CCD requires the commander to select the next map-based field before it is activated.

Selections are indicated by highlight and activation of the function selected, such as menu call-up with selection of a dedicated key or data entry with selection of an input option. If activation of a function is delayed, the Status/Alert window provides information on activation status, as previously described. Reselection of a menu field automatically clears that field, anticipating a change in data input.

Menu Structure

The user interface to the CCD is based on a menu structure. The menus for some functions require multiple-pages and each page is referred to as a screen. All menus and screens appear only in the Variable Menu window and only one screen is visible at a time. The menu structure is designed to provide the commander with direct access to any function. That is, the commander can override any current function simply by selecting a new one. This override capability results in overlapping menus, but it is intended to provide faster access to the user's immediate operational requirements.

An example of override is when the commander has partially completed a Situation report but needs to submit a Contact report rapidly. He can access the Contact report screen by selection of the dedicated CONTACT key without having to save his inputs on the Situation report or exit out of the Situation report menu. As the screen for the Contact report is called to the Variable Menu window, prior inputs made on the Situation report are saved and the commander's location in its menu structure is maintained. After the commander finishes with the Contact report, the CCD automatically returns to the Variable Menu window the commander's last visible Situation report screen and all report inputs as completed.

If the commander is preparing a multi-screen report, a summary screen is provided to allow the report to be reviewed and edited before transmission. This summary appears as the last screen of any multi-screen report. To edit the report's content the commander selects a field to edit, the Variable Menu returns the input screen required for editing that field. When all edits are completed, the commander can send or store the report, or post its icons to the tactical map.

The CCD incorporates several design features to assist commanders in maintaining their orientation in the menu structure (Muckler, 1984). Each menu or screen is titled to indicate its function. For multi-screen functions, this title is repeated on each screen and the screen or "page" number is provided. Menu-manipulation functions are labelled and located consistently. Access to all functions is initiated from the dedicated keys and multiple paths are provided for many functions. The override function allows a commander to access a required function directly with a dedicated key regardless of his current location in the menu structure.

Performance Measurement

As a central component in the CVCC research and development program, the CCD is an instrumented system. Instrumentation allows automatic recording of most user inputs and activities associated with system utilization. More specifically, this instrumentation includes the commander's activation and use of CCD map and report functions, data inputs and corrections made by the commander, and the time required to complete function and subfunction activities. Instrumentation supports identification of future C² system training requirements, redesign of the soldier-machine interface, and documentation of the system's operational effectiveness in CCTB-based combat operations.

Organization and Conventions for Detailed Description

This description of the CCD is structured by the menus and screens provided in the Variable Menu window for system operation. The hierarchical organization of the CCD's menu structure is illustrated in Appendix A. For each CCD screen,

a written description of the system function it provides is accompanied by a figure, or series of figures, depicting the fields and options available to the user for that function. Redundant figure citations are frequently provided in this description to explicate the interactive nature of these menu-based functions. Such citations may refer to distant figure placements and are to be used as the reader requires.

This detailed description begins with the CCD's Main screen and proceeds through the report, navigation, and map-manipulation screens and functions provided by the CCD. After a description of CCD message reception and the **RECEIVE** key, description continues with the **CONTACT** key and each dedicated key and its function in left-to-right order of appearance on the CCD (see Figure 5).

For clarity, the keys for accessing CCD functions such as **REPORT** or **MAP** are presented in bold text. All CCD functions and menus are initially accessed by selecting one of the dedicated keys. Some functions, however, are ultimately accessed through menu-based keys. **Map Scale** and **Move Vehicle** keys, for example, are available only after activation of the dedicated **MAP** key accesses the Map Functions screen. Menu-manipulation functions such as **CANCEL** and **PREP** are fully capitalized in text-based usage although initial capitals are used on the CCD screens, see the sample screen shown in Figure 8.

Each screen provides a number of input fields indicating the types of information associated with that function, such as the **What** or **Where** fields for designating unit type and location. Each input field has a number of formatted options for entering information such as the **Helo** (Helicopter) or **PC** (Personnel Carrier) options for completing the **What** fields. Fields and options are indicated textually with initial capitalization, the same as they appear on the figures depicting CCD screens, unless acronyms such as **PC** are used. Similarly, for clarification, the name of each CCD screen is provided in initial capitals when referred to in text.

A data element dictionary of all CCD input fields and formatted options is provided in Appendix B. This appendix provides a consolidated listing and reduces duplication in this description as identical option sets are not repeated on subsequent screen descriptions.

As noted, the commander can override any current function by activation of another. When the commander completes or cancels the override function, the Variable Menu redisplay the last screen visible before the override function was activated. Any such screen, accessed originally by the commander and redisplayed automatically by the CCD, is referred to as a Source Level screen. Source Level screen content, of course, varies with commander's use of the CCD. This screen retains all inputs made

Spot Report (P3)		
What	Obs	Dest
Helio	2	1
PC	4	3
Where:	65231564	
Hdg:	167°	
Enemy Act:	Air Air	
Own Act:	Fire	
As of:	15	
Cancel	+ Prep	

Figure 8. Sample Command and Control Display screen.

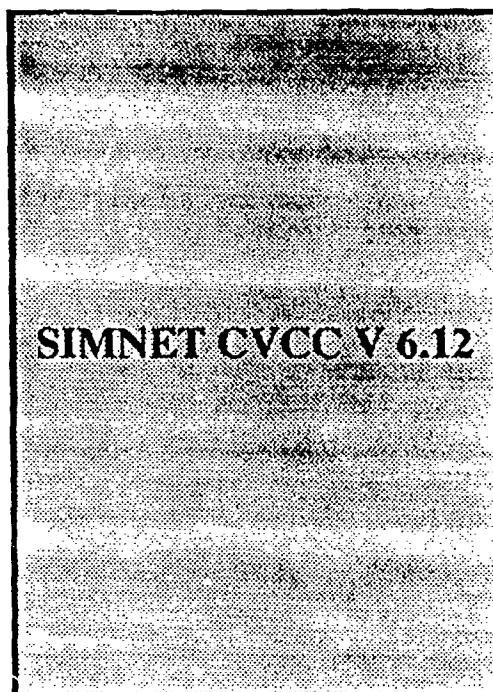


Figure 9. Main screen.

during prior activation and reminds the commander about functions initiated but not completed.

Main Screen

The purpose of the Main screen, Figure 9, depicting "SIMNET CVCC V 6.12" in the Variable Menu window is to provide feedback that all initiated CCD functions are completed or canceled. The Main screen is presented upon CCD initialization and reappears only after all accessed functions and Source Level screens are processed.

From the Main screen, as with any screen, the commander can activate any function designated by the eight dedicated keys: **RECEIVE**, **CONTACT**, **CFF** (Call For Fire), **NBC** (Nuclear, Biological, Chemical), **REPORT**, **NAV** (Navigation), **FOLLOW/JUMP**, and **MAP**. The **FOLLOW/JUMP** key is so named because its label and mode reverse with each selection. This function allows the commander to control the map area displayed by the CCD by providing automatic and manual modes for map manipulation. Upon CCD initialization, the **FOLLOW** label is displayed and the Follow mode for automatic map scroll is activated.

Received Messages Screen

Activation of the dedicated **RECEIVE** key brings the Received Messages screen to the Variable Menu window. This screen, shown

in Figure 10, provides the commander access to any messages sent to his CCD during the last five minutes that he has not yet processed.

As messages are received by the CCD, their report icons appear on the tactical map at the reported locations and flash for five seconds. At the same time, the **RECEIVE** key highlights and an auditory alert is presented in the commander's headset. The **RECEIVE** key remains highlighted until all received messages are acted on by the commander. Additional messages can be received at any time.

Messages available on the CCD are categorized as high or low priority depending on message type. Message-type priority is based on subject-matter-expert judgment. The following CCD message types are categorized high priority (priority one) messages: Adjust Fire, Call For Fire, Contact, Intelligence, and NBC. For a priority one message, the aural alert is three "beeps" sounded in the commander's headset. The remaining CCD message types (see Figure 18) are categorized as low priority (priority two) messages and only one beep is provided upon their reception.

When the commander activates **RECEIVE**, the message headers for all reports received in the last five minutes, but not yet acted on by the commander, appear on the Received Messages screen. A message header generally includes four items of information about the message.

For the highlighted Intel (Intelligence) message header depicted in Figure 10, the four items presented are: message status (X = not opened), message originator (Y06), message type (Intel), and message prepared time (1248). A message status indicator of "O" is used for messages opened. Under version 6.12, the message headers for Overlay reports differ from the standard message header. Overlay report headers display the name of the overlay such as FRAGO 1 (Fragmentary Order, number one) rather than the type of report. In addition, Overlay report headers provide a right-pointing arrow to indicate message relayed and a message posted (*) symbol to indicate the overlay is currently posted on the tactical map.

As noted, the commander's selection of a message header or its report icon highlights both elements. For report icons not currently visible on the displayed map area, message header selection highlights the report's icons and the arrows indicating direction to these icons.

If multiple message headers are present on the Received Messages screen, they are displayed in a queue of message headers. Queue order is based on time received and message priority. More recently received messages are stacked at the top of the queue, but high priority messages are stacked above low priority messages.

While this queue can display only five message headers at a time, it stores a sufficient number for all scenarios tested. If more than five messages are present in the queue, scroll arrows appear on this screen (Figure 10) indicating additional messages are available. The commander can move up or down the list of queued headers by selecting the appropriate scroll arrow. To provide some continuity as the queue scrolls, each arrow press retains the adjacent message header as four new message headers are depicted.

The three menu-manipulation functions on the Received Messages screen are CANCEL, DELETE, and SHOW. Selecting CANCEL returns the Source Level screen. DELETE causes the highlighted message header, message contents, and unposted icons to be removed from the CCD. SHOW brings the textual contents of the highlighted message to the Variable Menu window on a summary report screen.

Message content for each report received by a commander requires only one screen, with the exception of the Free Text report. This content is formatted in a manner that parallels the summary screens provided after preparing a multi-screen report. These formats will be described as each report type is addressed.

Sample Old Files Screen, Shell Report File

To avoid a build-up of message headers on the Received Messages screen and report icons on the tactical map, they are automatically transferred to a filing system called Old Files. These automatic message transfers occur five minutes after reception if the commander has taken no action on the message. Message actions by the commander such as message transmission or icon posting also result in message transfer to Old Files. Once transferred, the message header, report contents, and unposted report icons can only be accessed from Old Files. Messages in Old Files are stored by message type such as the Shell Report File depicted in Figure 11.

The automatic transfer of messages to Old Files attempts to reduce the commander's immediate workload requirements for information management. With voice-radio communications, commanders must process incoming messages sequentially and in the order received. With digital C² systems the commander may, for example, elect to process high priority (top of the queue) messages first while deferring action on low priority (e.g., transferred) messages.

The Old Files feature also stores all received and prepared messages on which the commander takes action, namely activation of a report's PREP key (e.g., Figure 12). The file for each message type is ordered by time as all messages within each file are the same type and priority. The message header for the most recently stored message is placed at the top of each queue. The queue of message headers for each file type is equipped with the

Received Messages			
Status	From	Type	When
▲			
X	Y06	Intel	1248
	A06	NBC	1247
O	Y06	Contact	1248
X	Y33	FRAGO 1	1247
	Y04	Shell	1246
▼			
Cancel	Delete	Show	

Figure 10. Received Messages screen.

Shell Report File	
Originator	When
▲	
A22	1920
B21	1910
Y03	1900
A23	1855
A23	1855
▼	
Cancel	Delete Show

Figure 11. Sample Old Files screen, Shell Report File.

scroll arrow mechanism, described for the Received Messages screen, to access message headers not currently visible.

All Old Files screens (e.g., Figure 11) have menu-manipulation functions for CANCEL, DELETE, and SHOW. Selecting CANCEL returns the Source Level screen. DELETE causes the highlighted message header, message contents, and unposted icons to be removed from the CCD. SHOW calls the textual contents of the highlighted message to the Variable Menu window on a summary report screen and displays the report's icons on the tactical map.

All CCD-based received messages can be accessed either from the Received Messages screen or Old Files. Received messages can't be edited by the receiver under Version 6.12. While the following description of each report type focuses on report preparation, each report type also supports message reception and relay. For messages prepared on the CCD, the screens used for report preparation, review, and relay are described and access to these screens is defined by report type (see also Appendix A).

Contact Report Screen

The purpose of the Contact report screen, Figure 12, is to report initial enemy contact. To prepare a Contact report, the commander accesses this screen with the dedicated CONTACT key or the menu-based CONTACT key on the Reports screen (see Figure 18).

As the first example of the procedures required for CCD report preparation, description of the Contact report screen provides additional and redundant detail on report field activation and completion. Report formats available on the CCD, such as Contact, are adapted from standardized Army reports (Department of the Army, 1984).

The Contact report screen has eight fields and two menu-manipulation functions. The eight fields include four What and four Where fields. As this screen appears, the first What and Where fields are highlighted to indicate they are active. The commander can complete active fields in any order.

The four What fields on the Contact report screen enable reporting on four different enemy types. The options for completing each What field are: Tank, Helo, FW Air (Fixed Wing Aircraft), Arty (Artillery), Truck, Troops, ATGM (Anti-Tank Guided Missile), and PC. Selecting an option is accomplished by cursor alignment and release on the required option. The selected option appears in the highlighted What field and its associated icon (Figure 6) is displayed on the tactical map after completion of its corresponding Where field.

After the commander inputs the first What option, the CCD highlights the next What field and displays its options. For this Contact report example, the option sets are the same for the four What fields. If an option for the What field is not selected, the miscellaneous type icon is displayed on the map when Where is designated.

There are also four Where fields for designating enemy report icon locations on the tactical map and their UTM grid coordinates in the Where fields. Location designation is accomplished by cursor alignment and release on the tactical map at the enemy's estimated location or by LRF activation from either the CITV or main gun.

The commander repeats the procedures for map-based inputs to adjust a Where input. To input location data for another enemy unit, the commander selects its corresponding Where field and then repeats the procedures for map-based inputs.

The two menu-manipulation functions available are CANCEL and PREP. CANCEL clears all menu and map inputs made on this report. CANCEL also removes the Contact report screen and returns the Source Level screen (e.g., the Main screen, the Reports screen, or the last screen visible in the Variable Menu window). PREP stores a copy of the report in Old Files under Contact reports and brings up the Report Action screen (Figure 13) to enable report transmission and/or posting of the report's icons.

Report Action Screen, Send and Post

The Report Action screen, shown in Figure 13, supports message relay and report icon posting to the tactical map. This screen has one field and three menu-manipulation functions. The Message Destination Address field indicates the combat radio nets available for report transmission. The combat radio net options are based on commander's duty position, see Table 2, and set during duty-position initialization of the SINCGARS. The Report Action screen lists the commander's available net options. In the Figure 13 example, nets assigned to the Alpha Company commander (A06) are Battalion (Bn) and Alpha Company (A Co).

In an effort to reduce commander workload, the CCD automatically selects the net anticipated (e.g., Bn in Figure 13) based on the type of report prepared for transmittal. Reports generally relayed downward on lower nets (i.e., Free Text, Intelligence and Overlay) preselect the commander's lower net. Similarly, for the remaining CCD reports (see Figure 18) generally relayed upward, the higher net is selected. The commander can override this default net selection, if more than one net is available at his position, to transmit on the alternate net or both nets simultaneously.

The three menu-manipulation functions are CANCEL, POST TO MAP, and SEND. CANCEL clears all inputs on a prepared report and returns the Source Level screen. The POST TO MAP function allows the commander to retain the icons for that report on the map.

When POST TO MAP is selected, the report's icons are temporarily boxed with a white border. When this screen is removed or replaced, these icons remain on the map but their white boxes are cleared. If not posted, the report's icons are cleared from the map as the commander acts on the report (CANCEL or SEND) or as it automatically transfers from the Received Messages screen (five minutes after reception).

With the exception of received Contact and Intelligence reports, the commander must personally post all report icons he wants to retain on the tactical map. To better ensure important information is not overlooked, Contact and Intelligence report icons are posted on the tactical map by the CCD before these reports are transferred automatically to Old Files.

Selecting SEND transmits the current report over SINCGARS to all CVCC-equipped operators on the radio nets highlighted. When the report is sent, "Message Sent" appears in the Status/Alert window as feedback on report transmission.

Suppression Screen for Call For Fire Report

The Suppression screen, shown in Figure 14, is used to prepare and forward a Call For Fire report. This report is a request for indirect fire on a target visible to the commander.

Table 2

Combat Radio Net Options by Duty Position

<u>Commander's Duty Position</u>	<u>Combat Radio Nets</u>
Wingman	Platoon
Platoon Sergeant	Platoon, Company
Platoon Leader	Platoon, Company
Company Executive Officer	Company, Battalion
Company Commander	Company, Battalion
Battalion Operations Officer	Battalion, Brigade
Battalion Commander	Battalion, Brigade

To prepare a Call For Fire report, the commander accesses this screen through the dedicated CFF key or the menu-based CFF key on the Reports screen (see Figure 18).

The Suppression screen has two fields and two menu-manipulation functions. The What field is for designating the target type to receive fire. Enemy target options are provided in Appendix B. If a target type is entered, its corresponding icon appears on the tactical map at the designated location. If the What field is not completed, the miscellaneous icon (Figure 6) is displayed. The Where field is used to designate the target location and input its grid coordinate. Input procedures for the Where field are identical to those described for other map-based inputs.

The two menu-manipulation functions are CANCEL and PREP. CANCEL clears all inputs made during report preparation and returns the Source Level screen to the Variable Menu window. PREP stores the report in Old Files and brings up the Report Action screen (Figure 13) for transmitting the prepared report. After a Call For Fire report is sent, the Variable Menu window automatically displays the Adjust Fire screen (see Figure 21) to allow adjustments on the initial Call For Fire report.

Nuclear, Biological, and Chemical Report Screens

The NBC report screens are used when NBC contamination is first encountered to alert other commanders and headquarters of NBC strike and contamination locations. Report of an initial NBC encounter parallels the NBC-1 report (Department of the Army, 1984). This report triggers units to take protective action and/or increase their Mission Oriented Protective Posture (MOPP). To prepare an NBC report, the commander accesses the first NBC screen with the dedicated NBC key or the menu-based NBC key on the Reports screen (see Figure 18).

The NBC report consists of three screens. The first two are used for inputting report data and the third is a summary screen. The first screen, shown in Figure 15, has four fields and two

Contact Report

What	Where
Helo	ES815880
PC	ES805897

Tank	Helo	FW Air
Arty	Truck	Troops
ATGM	PC	

Cancel	Prep
--------	-------------

Figure 12. Contact report screen.

Report Action

Forward to

☒ Bn

☐ A Co

Post to Map

Cancel	Send
--------	-------------

Figure 13. Report Action screen, send and post.

Suppression

What: **Troops**

Where: **ES811877**

Tank	Helo	FW Air
Arty	Truck	Troops
ATGM	PC	

Cancel	Prep
--------	-------------

Figure 14. Suppression screen for call for fire.

menu-manipulation functions. The fields are Obs Loc (Observer's Location), Atk Loc (Attack Location), Attack, and Burst.

The Obs Loc field is used to designate the location of the observer at the time of observation. The icon indicating observer's location (Figure 6) is displayed on the tactical map after entry in this field. The Atk Loc field is for designating the location of an NBC strike. Standard map-based input procedures are used for entering these two locations.

The Attack field allows designation of the attack type and its options are Nuclear, Biological, and Chemical. When the Attack option is selected, the appropriate icon (see Figure 6) is displayed on the map at the attack location previously specified. If the Atk Loc field is completed before the NBC agent is input, a red miscellaneous icon is displayed on the map. The Burst field is for designating the type of agent the NBC delivery system used and its options are Air and Surface.

The two menu-manipulation functions are CANCEL and NEXT. CANCEL clears all inputs made during preparation of this report and returns the Source Level screen. NEXT brings up the second NBC screen.

The second NBC screen, shown in Figure 16, has five fields and three menu-manipulation functions. The fields are: Flash/Bang Time; Number Shells; Nuc Crtr Diam (m) (Nuclear Crater Diameter, in meters); Nuc Cloud Wi (deg) (Nuclear Cloud Width, in degrees); and Nuc Cloud Ht (deg) (Nuclear Cloud Height, in degrees). The numeric option sets for each of these fields are provided in Appendix B.

The Flash/Bang Time field is used to specify the flash-to-bang interval in seconds. The Number Shells field allows designation of the number of shells that delivered the NBC contamination. The Nuc Crtr Diam (m) field is for indicating the diameter of the nuclear crater in meters. The Nuc Cloud Wi (deg) and Nuc Cloud Ht (deg) fields are used to provide width and height of the nuclear cloud in degrees.

The three menu-manipulation functions for this screen are CANCEL, BACK, and NEXT. CANCEL clears all inputs made during preparation of the report and returns the Source Level screen. BACK returns the first NBC screen and NEXT brings up the NBC summary screen, page three.

The third screen, shown in Figure 17, is the summary screen. On all prepared reports, the summary screen allows the commander to review and edit a report he has prepared. Selection of a report field on this screen returns that field's associated input screen to enable revision of the original entry. Revision procedures are identical to the original input procedures. After editing, the commander returns to the revised summary screen by

NBC Report (P1)

Obs Loc	ES973567
Atk Loc	ES589321
Attack	Nuclear
Burst	Air
	<div>Nuclear</div> <div>Biological</div> <div>Chemical</div>
Cancel	Next

Figure 15. NBC report screen, page one.

NBC Report (P2)

Flash/Bang Time	5
Number Shells	2
Nuc Crtr Diam(m)	12
Nuc Cloud Wid(deg)	14
Nuc Cloud Ht(deg)	18
<div>n/a 1 2 3 4</div> <div>5 6 7 8 9</div> <div>10 12 14 16 18</div>	
Cancel	Back +Next

Figure 16. NBC Report screen, page two.

NBC Report (P3)

Obs Loc	ES973567
Atk Loc	ES589321
Attack Type	Nuclear
Burst Type	Air
Flash/Bang Time	5
Number Shells	2
Nuc Crtr Diam(m)	12
Nuc Cloud Wid(deg)	14
Nuc Cloud Ht(deg)	18
Cancel	Back +Prep

Figure 17. NBC report screen, page three.

selecting NEXT until the summary screen appears in the Variable Menu window.

The menu-manipulation functions for the NBC summary screen are CANCEL, BACK, and PREP. CANCEL clears all inputs made during preparation of this report and returns the Source Level screen and BACK returns the second NBC screen. PREP stores the report in Old Files and brings up the Report Action screen (Figure 13).

Reports Screen

The purpose of the Reports screen is to allow the commander to prepare a new report or to enter an old message file to access a report previously prepared or received. The Reports screen, shown in Figure 18, is accessed through the dedicated REPORT key.

The Reports screen provides the commander a consolidated menu containing all the report types currently available on the CCD. This screen provides a redundant path (see Appendix A menu structure) for accessing the report preparation screens used in Contact, Call For Fire, and NBC reports. Dedicated keys for these three report types are provided to expedite their preparation. These three report types are repeated on the Reports screen to enable their access under Old Files and provide an integrated menu with all CCD report types.

The Reports screen displays thirteen report types and provides three menu-manipulation functions. The Logistics (LOG) and Fragmentary Order (FRAGO) report functions are grayed-out and not available under version 6.12. An approximate form of a FRAGO report can be developed by preparing an Overlay report (graphic only) and a related Free Text report. The eleven reports available for selection are: ADJUST, AMMO, CFF, CONTACT, INTEL, NBC, SHELL, SPOT, FREE TEXT, OVERLAY, and SITREP. Only one report type can be selected at a time.

The three menu-manipulation functions are OLD, NEW, and CANCEL. After selection of a report type, OLD takes the commander to the Old Files for the type of report selected. For example, if the commander wants to review Shell reports, he selects SHELL from the Reports screen and then OLD. A listing of the message headers for all of the Shell reports available in the Old Files (see Figure 11) is then displayed in the Variable Menu window.

After selection of a report type, NEW displays the first screen required for preparing the report type selected. NEW is grayed-out and nonfunctional when FREE TEXT or OVERLAY is selected. Under version 6.12, these reports cannot be prepared by a commander in a tank simulator. They are prepared by TOC-based operators and relayed to the simulators. CANCEL returns the Source Level screen.

Adjust Fire Report Screen

The Adjust Fire report screen, Figure 19, is used to modify prior calls for indirect fire (see Suppression screen, Figure 14). This screen is accessed automatically by sending a Call For Fire report or by the commander selecting **Adjust** on the Reports screen (see Figure 18).

In adjusting fire, the commander provides feedback to the artillery units so they can redirect their rounds to land in the desired location. The commander's adjustments are revised target locations or shifts in location from where the prior rounds impacted.

The Adjust Fire screen has five fields and two menu-manipulation functions. The fields include Target (location), Shift (left or right), Shift (add or drop), FFE (Fire For Effect), and EOM (End Of Mission). The commander must decide to adjust fires by using either the Target field or the Shift fields. The Target field is for designating a revised target location and is input the same as any map-based entry. If the commander elects to shift fires, the Left and Right shift options and the Add and Drop shift options are specified in meters (see Appendix B for shift options).

FFE is generally input after the rounds are adjusted to the desired location. When the Adjust Fire report is transmitted with FFE highlighted, the firing unit is informed that final destructive fires can now be released on the target. After the target is destroyed or sufficiently suppressed, the EOM option should be input to inform the firing unit the fire mission and adjustment requests are completed. If EOM is not included in an Adjust Fire report, the CCD returns the Adjust Fire screen when an adjustment request is transmitted.

The two menu-manipulation functions are CANCEL and PREP. CANCEL clears all inputs made during preparation of this report and returns the Source Level screen. PREP stores the report in Old Files and brings up the Report Action screen (Figure 13).

Ammunition Status Report Screen

The Ammunition Status report screen allows the commander to prepare a count of ammunition rounds available to inform combat support units and assist in mission readiness determinations. The Ammunition Status report screen, shown in Figure 20, is accessed by selecting **Ammo** on the Reports screen (see Figure 18).

This screen provides five fields and two menu-manipulation functions. The fields are Heat, Sabot, .50 CAL (caliber), 7.62 mm (millimeter), and Smoke. The options available for each of the fields are Green, Amber, Red, and Black (GARB). These status indicators correspond to the following combat effectiveness ratings, respectively: 90-100%, 80-89%, 60-79% and 0-59%

Reports	
Enemy	Friend
<input checked="" type="checkbox"/> Adjust	<input type="checkbox"/> FRAGO
<input type="checkbox"/> Ammo	<input type="checkbox"/> Free Text
<input type="checkbox"/> CFF	<input type="checkbox"/> Log
<input type="checkbox"/> Contact	<input type="checkbox"/> Overlay
<input type="checkbox"/> Intel	<input type="checkbox"/> Sit Rep
<input type="checkbox"/> NBC	
<input type="checkbox"/> Shell	
<input type="checkbox"/> Spot	
<input type="button" value="Cancel"/>	<input type="button" value="Old"/> <input type="button" value="+New"/>

Figure 18. Reports screen

Adjust Fire	
Target:	<input type="text"/>
-- Or --	
Shift:	<input type="button" value="L100"/> <input type="button" value="A200"/>
<input type="checkbox"/> FFE	<input checked="" type="checkbox"/> EOM
<input type="button" value="0"/>	<input type="button" value="L 50"/> <input type="button" value="L 100"/>
<input type="button" value="L 150"/>	<input type="button" value="L 200"/> <input type="button" value="R 50"/>
<input type="button" value="R 100"/>	<input type="button" value="R 150"/> <input type="button" value="R 200"/>
<input type="button" value="Cancel"/>	<input type="button" value="Prep"/>

Figure 19. Adjust Fire report screen.

(Department of the Army, 1985). The Heat and Sabot fields for main gun ammunition receive their inputs automatically from the autoloader (see Combat Vehicle Command and Control Component Integration section). All other ammunition fields receive their inputs from the commander.

The two menu-manipulation functions are CANCEL and PREP. CANCEL clears all inputs made during preparation of this report and returns the Source Level screen. PREP stores the report in Old Files and brings up the Report Action screen, send only (Figure 21).

Report Action Screen, Send Only

In contrast to the Report Action screen for post and send (Figure 13), the Report Action screen for send only (Figure 21) is used for transmitting message types that have no report icons for posting. This screen is accessed by selecting PREP on the following CCD screens: Ammunition Status, Free Text, Overlay, Situation, Route Designation, and Route Files. All other CCD report types (see Figure 18) access the Report Action screen for post and send when PREP is selected. The Report Action screen for send only has the same fields and input procedures as described for Figure 13, except for Post To Map.

Ammunition Status	
Ammo	Status
Heat	<input checked="" type="checkbox"/> Green
Sabot	<input type="checkbox"/> Black
.50 CAL	<input type="checkbox"/> Amber
7.62mm	<input type="checkbox"/> Red
Smoke	<input type="checkbox"/> Green
<input checked="" type="checkbox"/> Green <input type="checkbox"/> Amber <input type="checkbox"/> Red	
<input type="checkbox"/> Black	
<input type="checkbox"/> Cancel <input checked="" type="checkbox"/> Prep	

Figure 20. Ammunition Status report screen.

Report Action	
Forward to:	
<input checked="" type="checkbox"/>	Bn
<input type="checkbox"/>	A Co
<input type="checkbox"/> Cancel <input checked="" type="checkbox"/> Send	

Figure 21. Report Action screen, send only.

Intelligence Report Screens

The Intelligence report screens allow the commander to prepare a detailed report on enemy activity, friendly activity, and obstacles. This report is accessed through the Intel key on the Reports screen (see Figure 18) and consists of four screens including a report summary screen.

The first screen, shown in Figure 22, has five fields and two menu-manipulation functions. The fields are What, Number, Where, Activity, and Hdg (Heading). The What field is for selecting the type of enemy encountered. Number of enemy vehicles encountered is displayed in the Number field. The Where field is used to designate the location of the enemy encountered and display its grid coordinate. If the enemy type is already selected, the corresponding icon appears in the designated location. Standard menu- and map-based input procedures are used to complete these fields and the option set for each is provided in Appendix B.

The current activity of the enemy is displayed in the Activity field and the available options are Gnd Atk (Ground Attack), Air Atk (Air Attack), Fire, Defend, Delay, and Recon (Reconnaissance). The Hdg field is for designating the direction of enemy movement. After the commander determines enemy direction, he inputs enemy heading by selecting a map location relative to this report's enemy icon on the tactical map. If the

enemy is heading North, for example, the commander selects a map location directly above this report's icon. The CCD then determines the direction indicated and enters this value in degrees into the Hdg field. The commander can change this heading entry by simply selecting another map location.

The two menu-manipulation functions are CANCEL and NEXT. CANCEL clears all inputs made during preparation of this report and returns the Source Level screen. NEXT brings up the second Intelligence report screen.

The second screen, shown in Figure 23, is similar to the first except that its inputs are for friendly units and a BACK function for menu manipulation is included. The friendly unit options available are Arty, C2, Mech (Mechanized), Mortars, Scout, Supp (Supply), and Tank. A miscellaneous blue icon appears on the map at the designated friendly location regardless of unit type entered. All other fields, options, and input procedures are the same as on the first screen. BACK returns the first Intelligence report screen.

The third screen, shown in Figure 24, is for preparing information on battlefield obstacles. This screen has four fields and three menu-manipulation functions. The fields are What, As Of, and two Where fields. The obstacle type selected is displayed in the What field and its options are Abati, Blown Bridge, Minefield, and Tank Ditch. The As Of field is used to indicate elapsed time since the obstacle was encountered or emplaced. As Of field options are provided in Appendix B. The Where fields are used to designate grid coordinates at the end of each obstacle and miscellaneous red icons are displayed in each of the designated locations.

The three menu-manipulation functions are CANCEL, BACK, and NEXT. CANCEL clears all inputs made during preparation of this report and returns the Source Level screen. BACK returns the screen to the second Intelligence report screen, and NEXT brings up this report's summary screen.

The fourth screen, shown in Figure 25, is a summary screen. Selecting a field brings up that field's associated screen for editing the report's content. The three menu-manipulation functions are CANCEL, BACK, and PREP. CANCEL clears all inputs made during preparation of this report and returns the Source Level screen. BACK returns the third Intelligence report screen, and PREP stores the report in Old Files and brings up the Report Action screen (Figure 13).

Shell Report Screen

The Shell report screen, shown in Figure 26, allows the commander to prepare a report on observed incoming artillery rounds. This screen is accessed by selecting Shell on the Reports screen (see Figure 18).

Intelligence (P1)

Enemy Unit

What:

Number:

Where:

Activity:

Hdg:

Figure 22. Intelligence report screen, page one.

Intelligence (P2)

Friendly Unit

What:

Number:

Where:

Activity:

Hdg:

Figure 23. Intelligence report screen, page two.

Intelligence (P3)

Obstacle

What:

Where:

As of:

Figure 24. Intelligence report screen, page three.

Intelligence (P4)

Enemy:

Friend:

Obstacle:

As Of:

Figure 25. Intelligence report screen, page four.

The Shell report screen has three fields and two menu-manipulation functions. The three fields are Number, Where, and As Of. The number of incoming shells is displayed in the Number field (Appendix B). The Where field is used for specifying the incoming round's impact location by grid coordinate and the miscellaneous red icon is displayed on the map at the designated location. The As Of field is used to indicate the time of the observation.

The two menu-manipulation functions available are CANCEL and PREP. Selecting CANCEL clears all inputs made during preparation of this report and returns the Source Level screen. PREP stores the report in Old Files and accesses the Report Action screen (Figure 13).

Spot Report Screens

The purpose of the Spot report screens is to prepare a detailed report on the enemy's current situation and activity. The first screen is accessed by selecting Spot on the Reports screen (see Figure 18).

The Spot report consists of three screens. The first two are for report input and the last one is a summary screen. The first screen, shown in Figure 27, has eight fields and two menu-manipulation functions. There are two fields each for What, Obs (Observed), and Dest (Destroyed), and one field for both Where and Hdg. The What fields designate the selected type of enemy encountered. The Obs fields indicate the number of enemy observed, and the Dest fields are for designating the number of enemy destroyed (Appendix B). The Where and Hdg fields are used to indicate location and heading of the enemy unit encountered.

The two menu-manipulation functions are CANCEL and NEXT. CANCEL clears all inputs made during preparation of this report and returns the Source Level screen. NEXT brings up the second Spot report screen.

The second screen, shown in Figure 28, has three fields and three menu-manipulation functions. The fields are Enemy Act (Activity), Own Act, and As Of. The enemy's current activity is entered in the Enemy Act field, and the Own Act field is for specifying the activity of the vehicle or unit sending the report. The options for these two fields are Gnd Atk, Air Atk, Fire, Defend, Delay, and Recon. As Of is for designating the observation time.

The three menu-manipulation functions are CANCEL, NEXT, and BACK. CANCEL clears all inputs made for preparation of this report and returns the Source Level screen. NEXT brings up the summary Spot report screen, and BACK brings up the first Spot report screen.

Shell Report																
Number:	40															
Where:	ES798895															
As Of:	Now															
<table border="1"> <tr> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td> </tr> <tr> <td>7</td><td>10</td><td>15</td><td>20</td><td>30</td> </tr> <tr> <td>40</td><td>50</td><td>60</td><td>75</td><td>100</td> </tr> </table>		1	2	3	4	5	7	10	15	20	30	40	50	60	75	100
1	2	3	4	5												
7	10	15	20	30												
40	50	60	75	100												
Cancel	+Prep															

Figure 26. Shell report screen.

Spot Report (P1)		
What	Obs	Dest
Helo	2	1
PC	4	3
Where:	ES789867	
Hdg:	167	
Tank	Helo	FW Air
Arty	Truck	Troops
ATGM	PC	
Cancel	+Next	

Figure 27. Spot report screen, page one.

The third screen, shown in Figure 29, is the summary screen. Selecting a field accesses its associated input screen for editing the report's content. The menu-manipulation functions are CANCEL, BACK, and PREP. CANCEL clears all inputs made during preparation of this report and returns the Source Level screen. BACK returns the second Spot report screen, and PREP stores the report in Old Files and brings up the Report Action screen (Figure 13).

Situation Report Screens

The purpose of the Situation report screens is to inform other commanders or headquarters of the commander's current situation. This report relays information concerning the current level and type of enemy activity as well as the reporting unit's current situation in terms of location, critical shortages, and mission intention. The commander accesses the first Situation report screen by selecting Sit Rep on the Reports screen (see Figure 18).

The Situation Report consists of three screens. The first two are for entering report data and the last is a summary screen. The first screen, shown in Figure 30, has five fields including an As Of field, two Forward Line of Own Troops (FLOT) fields, and two Enemy Act fields. The time of the situational assessment is displayed in the As Of field.

Spot Report (P2)	
Enemy Act:	Air Atk
Own Act:	Fire
As of:	-15
Gnd Atk	Air Atk
Fire	Defend
Delay	Recon
Cancel	Back
	Next

Figure 28. Spot report screen, page two.

Spot Report (P3)		
What	Obs	Dest
Helo	2	1
PC	4	3
Where:	ES789867	
Hdg:	167°	
Enemy Act:	Air Atk	
Own Act:	Fire	
As of:	-15	
Cancel	Back	Prep

Figure 29. Spot report screen, page three.

A FLOT is generally a line specified by a series of grid coordinates that indicates where a unit's troops are deployed. For the CVCC 6.12 version, the specified end-point coordinates are entered in the FLOT fields but no icons appear on the map. The first Enemy Act field is for qualitatively describing the intensity of enemy activity and the options are Light, Medium, and Heavy. The second Enemy Act field defines the type of enemy activity (see Appendix B).

The first screen's two menu-manipulation functions are CANCEL and NEXT. CANCEL clears all inputs made during preparation of this report and returns the Source Level screen. NEXT brings up the second Situation report screen.

The second screen, shown in Figure 31, has two fields. The first field is Crit. Short (Critical Shortages). The four critical shortage options are Pers (Personnel), Ammo (Ammunition), Fuel, and Equip (Equipment). Shortage data is nominal. A critical shortage field can either be highlighted or not, and critical shortages for multiple fields can be indicated in the same report. The Cdr Intent (Commander's Intent) field is for designating the course of action the commander intends to execute and the options are No Change, Attack, Recon, Defend, Delay, and Withdraw.

The three menu-manipulation functions on the second screen are CANCEL, BACK, and NEXT. CANCEL clears all inputs made during

preparation of this report and returns the Source Level screen. BACK brings up the first Situation report screen, and NEXT brings up the third Situation report screen.

The third screen, shown in Figure 32, is a summary screen with menu-manipulation functions for CANCEL, BACK, and PREP. Selecting a field brings up its associated screen for editing of the report's content. CANCEL clears all inputs made during preparation of this report and returns the Source Level screen. BACK returns the screen to the second Situation report screen. PREP stores the report in Old Files and brings up the Report Action screen (Figure 21).

Free Text Report Screen

From the Reports screen (see Figure 18), selection of **Free Text** and then OLD allows the commander to access the Free Text message headers and reports transferred to Old Files. Reports transferred include manual transfers by the commander's activation of the PREP key and automatic transfers by the CCD as described in the Received Messages screen section. Prior to their transfer to Old Files, all Free Text reports are available under the Received Messages screen (Figure 10). As noted, the commander cannot prepare a Free Text report and NEW is grayed-out when this report type is selected.

Free Text reports are nonformatted messages prepared by the battalion TOC's command and staff operators using keyboards available at their CVCC stations. This report's lack of format allows the originator of a free text message to convey a wide range of alphanumeric information not included in the available CCD message types and their preformatted fields and options.

Selection of **Free Text** and then OLD on the Reports screen accesses from Old Files a queue of Free Text message headers similar to the Shell Report File (see Figure 11), except for report type. From this Free Text Report File, the commander's selection of a Free Text report message header and the SHOW key accesses the first Free Text report screen (Figure 33). A Free Text report includes no report icons. Additional report screens can be accessed if the message is a multiple-screen report.

There are no input fields on the Free Text report screen. The three menu-manipulation functions are CANCEL, DELETE, and PREP. CANCEL returns the Source Level screen, and DELETE removes the Free Text report from the CCD. PREP brings up the Report Action screen (Figure 21) to allow the commander to relay the report to other CCD-equipped vehicles.

Overlay Report Screen

The Overlay report screen provides vehicle-based commanders a unique capability to receive and display operational graphics on the CCD's tactical map. Operational overlays are a set of

Situation Report (P1)

As of: **-30**

FLOT: **ES795905**
ES788897

Enemy Act: **Heavy**
Defend

Now **-5** **-10**
-15 **-30** **-45**

Cancel **Next**

Figure 30. Situation report screen, page one.

Situation Report (P2)

☐ Pers
Crit. Short ☐ Ammo
☐ Fuel
☒ Equip

Cdr Intent: **Attack**

No Change **Attack**
Recon **Defend**
Delay **Withdraw**

Cancel **Back** **+Next**

Figure 31. Situation report screen, page two.

Situation Report (P3)

As of: **-30**

FLOT **ES795905**
ES788897

Enemy Act: **Heavy**
Defend

Crit Short: **E**

Cdr Intent: **Attack**

Cancel **Back** **+Prep**

Figure 32. Situation report screen, page three.

control measures, a "blueprint" of the operation, that direct mission execution and assist in command and control of the force. The overlays are prepared by command and staff operators at the TOC's CVCC stations and relayed to the vehicle-based commanders. A commander accesses the Overlay screen, shown in Figure 34, by selecting **Overlay** from the Reports screen (see Figure 18) and then **OLD**, or **Overlay** from the Map screen (see Figure 38).

The three menu-manipulation functions available on the Overlay report screen are **EXIT**, **POST**, and **PREP**. **EXIT** returns the Source Level screen, namely the Reports screen or Map Functions screen. To activate **POST** or **PREP** functions, the commander must first select an overlay message header. **POST** displays the selected overlay on the tactical map and inserts an asterisk (*) in that overlay's message header indicating it is posted.

Similarly, to remove an overlay from the map area, the commander must first select its message header causing the **POST** label to change to **UNPOST**. Selecting **UNPOST** removes the overlay from the map and the asterisk from the message header, but retains the message header on the Overlay report screen for future access. **PREP** accesses the Report Action screen (Figure 21) to enable transmission of the overlay to other CVCC-equipped systems.

Route Designation Screen

The Route Designation screen, shown in Figure 35, allows the commander to designate a vehicle or unit route, pass route waypoints to the driver's STI, access route files, or transmit a route to other vehicles. This screen is accessed through the dedicated **NAV** key (Figure 5). There are 14 fields and five menu-manipulation functions on this screen. Of the 14 fields, the six waypoint location fields under the label **Commander** are for designating a route.

To designate a route, the commander inputs the first waypoint by entering a map-based location. The system verifies this input by displaying a **WP1** (Waypoint 1) icon on the map at the designated location and its grid coordinate in the **Location** field. The commander can modify this waypoint's location by designating a new map location. The commander must select another waypoint field and repeat the above procedure to input a second waypoint. As successive waypoints are entered by the commander, a solid line (route leg) appears on the tactical map connecting each pair of waypoints.

The eight fields under the label **Driver** allow the commander to pass waypoint information to the driver through the STI (see Figure 4). As noted, the STI provides the current waypoint number, distance to the waypoint, vehicle heading, deviation between vehicle and waypoint headings, and an indicator showing the steer-to direction to the current waypoint. Information on only one waypoint can be transmitted at a time and a **Driver** field

Free Text Report
From Y06 at 1226

A Co move to ES756920.

Defend Objective
Bronze.

Orient between TRPs
A013 and A026.

Report when set.

Cancel Delete Prep

Figure 33. Free Text report screen.

Overlay Report

Stat	Orig	Name	Post	Time
X	Y33	FRAGO 2		1450
O	Y33	FRAGO 1 *		1405
O	N06	OPORD 1 *		1320

Exit Post Prep

Figure 34. Overlay report screen.

must be activated to transmit the information to the STI. When any of the six individual waypoint Driver fields is activated, a solid line is drawn on the tactical map from the own-vehicle icon to that waypoint as feedback to the commander.

The None and Auto Adv (Automatic Advance) Driver fields determine how, or if, waypoints are to be transmitted to the STI. Selecting None cancels the transmission of waypoints to the driver and clears the STI waypoint data. Selecting Auto Adv enables the CCD to transmit waypoint data in route order automatically.

Under Auto Adv, when the vehicle gets to within 100 meters of the current waypoint location, data for the next waypoint is sent automatically to the STI. Auditory and visual feedback is presented to the commander and the driver to indicate when a waypoint has advanced. A beep sounds in each of their headsets and an "Updating Waypoint" message appears on the STI and in the Status/Alert window of the CCD. The commander must forward each waypoint to the driver if Auto Adv is not activated.

The five menu-manipulation functions available are EXIT, SAVE, PREP, CLR FLD (Clear Field), and FILES. EXIT returns the Source Level screen. SAVE stores the designated route in a file called Route Files. PREP accesses the Report Action screen (Figure 21) to enable transmission of the currently designated route. Unlike other CCD menu-based transmissions, when a route

is sent from the Report Action screen the Route Designation screen is redisplayed.

CLR FLD allows the commander to edit the route designated. After selection of a waypoint location field, activation of CLR FLD deletes that waypoint from the tactical map and its location entry from the waypoint field. If additional waypoints are to be cleared, they must first be selected. Selecting FILES brings up the Route Files screen.

Route Files Screen

The Route Files screen is used to send, review, activate and relay previously stored routes. The commander accesses the Route Files screen, shown in Figure 36, by selecting FILES on the Route Designation screen.

The Route Files screen consists of one field and four menu-manipulation functions. The field is a chronological list of all stored route headers with the most recent route at the top of the list. The list can display up to eight route headers per screen and scroll arrows are provided to access additional headers (see Received Messages Screen section). The stored routes are displayed by the originator's call sign and the time each route was stored.

To enable prompt review of a stored route, the commander's selection of a route header displays its waypoint coordinates on this screen under Selected Route (see Figure 36) and its waypoint icons on the tactical map. The route legs for this selected route are depicted on tactical map and connected with dashed lines indicating it is a "proposed" or nonactive route. The commander's active route is still displayed with solid lines indicating "current" route.

The four menu-manipulation functions are BACK, PREP, MAKE ACTIVE, and DELETE. Both DELETE and MAKE ACTIVE are used in conjunction with selection of a route header. DELETE removes the selected route from the CCD. MAKE ACTIVE revises the selected route on the tactical map by changing the dashed lines to solid lines indicating it is now the current route. MAKE ACTIVE also removes the previously active route from the tactical map and returns the Route Designation screen displaying the waypoint coordinates for this new route. BACK returns the Route Designation screen (see Figure 35) and PREP accesses the Report Action screen (Figure 21).

Follow/Jump Functions

The Jump function enables quick manipulation of the map area displayed while performing another CCD function, such as viewing an off-map report icon while reading its report contents in the Variable Menu window or entering a series of waypoints under the

Route Designation		
Driver		Commander
<input type="checkbox"/>	W1	ES785905
<input type="checkbox"/>	W2	ES770910
<input checked="" type="checkbox"/>	W3	ES756920
<input type="checkbox"/>	W4	
<input type="checkbox"/>	W5	
<input type="checkbox"/>	W6	
<input type="checkbox"/>	none	Clr Fld
<input checked="" type="checkbox"/>	Auto Adv	Files
<div>Exit</div> <div>Save</div> <div>Prep</div>		

Figure 35. Route Designation screen.

Route Files		
Call Sign	Time	Selected Route
Y06	1115	ES805920
B06	1035	ES780925
C06	0930	ES750935
B06	0900	
▼		
Make Active		Delete
Back		Prep

Figure 36. Route Files screen.

route designate function. The commander accesses the Jump function through the dedicated **FOLLOW/JUMP** key.

As noted, the label for this key toggles between **FOLLOW** and **JUMP** with each selection. The label currently displayed indicates the function or mode currently active. When the CCD is initialized, the default label and mode is **FOLLOW** with the commander's vehicle at the center of the tactical map. In this mode, the map scrolls beneath the own-vehicle icon as the simulator moves across the terrain data base.

When **FOLLOW** is selected, the **JUMP** label and mode are activated and eight map manipulation boxes appear on the borders of the tactical map (Figure 37). Each jump box is red, outlined in white, with a white "J" in its center. When one of the jump boxes is selected, the map moves or "jumps" to display more of the terrain in the direction of the box chosen. This map movement is slightly less than half of the displayed map area to ensure the commander's vehicle remains visible on the map after the first jump.

The first activation of the lower-center box, for example, repositions the map to display more of the Southern map region and shifts the own-vehicle icon to the Northern border of the Tactical Map window. If the commander now moves his simulator, the own-vehicle icon moves across the map and can be "driven" off the area displayed. If the own-vehicle icon leaves the visible

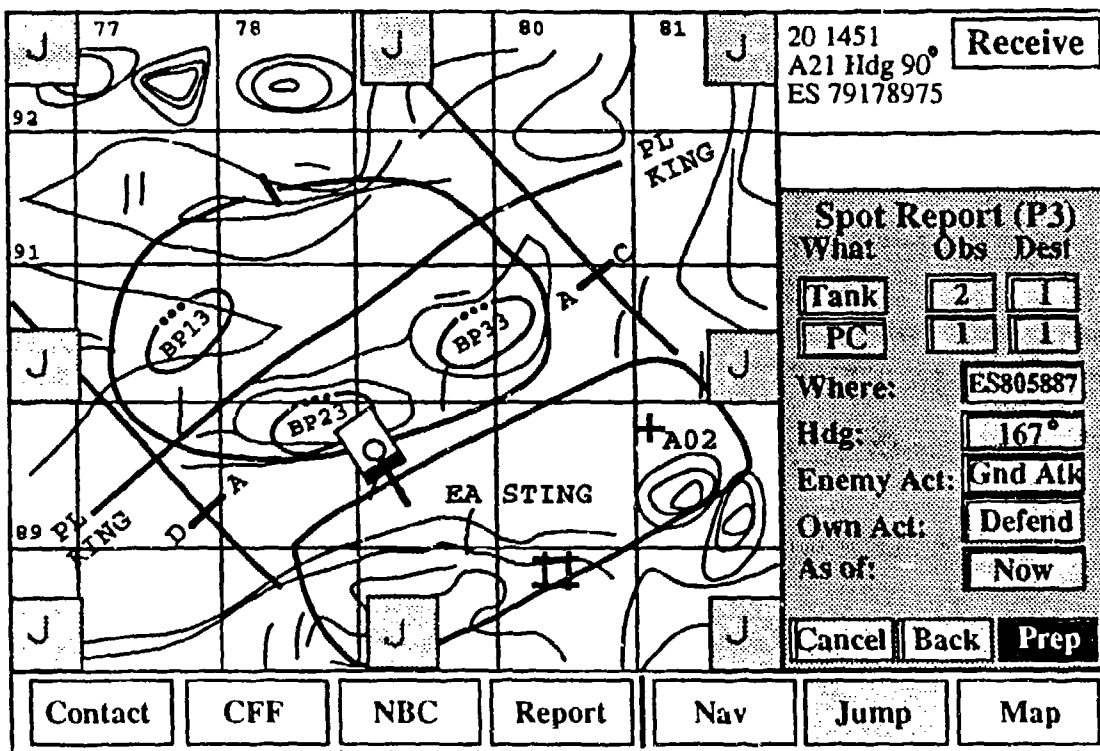


Figure 37. Jump screen, Jump mode activated.

map area (e.g., with successive jumps) a blue arrowhead appears to indicate direction to the own-vehicle icon.

When the desired map area is displayed, the commander can review the map information now visible and/or provide map- and menu-based inputs related to this area. When the JUMP key is selected, the FOLLOW label and mode are activated and the vehicle and map return to their locations prior to activation of the JUMP function.

Map Functions Screen

The purpose of the Map Functions screen is to allow the commander to tailor the CCD's tactical map to his operational requirements. The commander accesses the Map Functions screen, shown in Figure 38, through the dedicated MAP key.

Two fields and four additional screens can be accessed from the Map Functions screen. The two available fields are **Scale** and **Move Vehicle**. The four function keys are **Features**, **Posted Icons**, **Agg**, and **Overlays** and each is used to access its respective screen and function. EXIT returns the Source Level screen.

Scale provides the four map scale options of 1:25,000, 1:50,000, 1:125,000, and 1:250,000. Only one map scale can be selected at a time and any operational overlay depicted on the

map is rescaled with each change in scale. The prompt "Map Rescaling" appears in the Status/Alert area as scale requests are processed to indicate the system is rescaling (10- to 20-second updates) the tactical map display. The prior section titled Tactical Map and Map Manipulation provides additional information on CCD capabilities for map rescaling.

Move Vehicle allows the commander to relocate, off-center, his vehicle icon on the tactical map display while retaining the automatic map scroll capability. This feature enables the commander, for example, to move his vehicle icon to the lower left (SW) corner of the map display area to view more of the forward battlefield area as his unit maneuvers NE.

When **Move Vehicle** is selected, the dedicated **FOLLOW/JUMP** key changes to **MOVE** informing the commander that the CCD is in the Move Vehicle mode. If the commander now selects a locale on the tactical map display, his vehicle icon moves to the position selected. At the same time, the map repositions to keep his vehicle icon at its actual map location. Successive location selections allow the commander to adjust vehicle location as required.

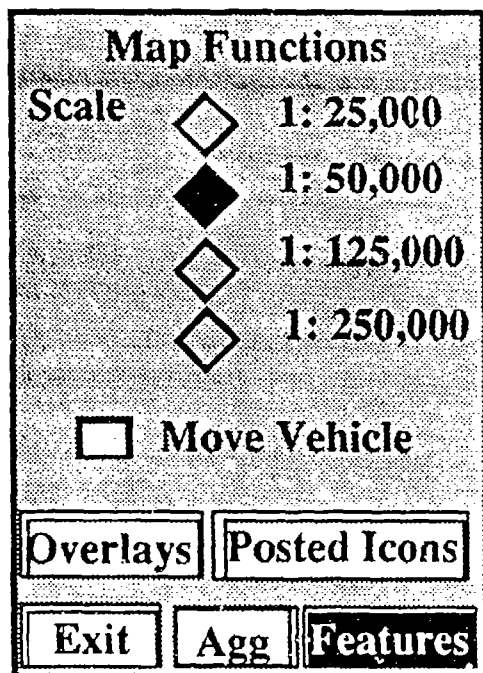
Reselection of **Move Vehicle** exits the function, "locks" the last own-vehicle location designated, and changes the **MOVE** label back to **FOLLOW/JUMP**. If the commander's simulator is now driven across the terrain data base, the own-vehicle icon remains at the location designated as the map scrolls beneath it.

Visible Map Features Screen

The Visible Map Features screen allows the commander to select the man-made and natural terrain features to be displayed on his tactical map. The commander accesses the Visible Map Features screen, shown in Figure 39, by selecting **Features** from the Map Functions screen.

The Visible Map Features screen has five fields and one menu-manipulation function. The fields are Contour Lines, Grid Lines, Rivers, Roads, and Vegetation. Selecting any field, or combination of fields, posts the corresponding features to the map and highlights their fields. Deselection removes the features and grays-out their associated fields. Vegetation is not available at the lower scales of 1:125,000 and 1:250,000 to reduce map clutter. **BACK** returns the Map Functions screen.

The ability to select map features individually or in combination allows the commander to tailor his map display as required and declutter the limited map area. The prior section titled Tactical Map and Map Manipulation provides additional information on CCD capabilities for terrain feature display.



Map Functions

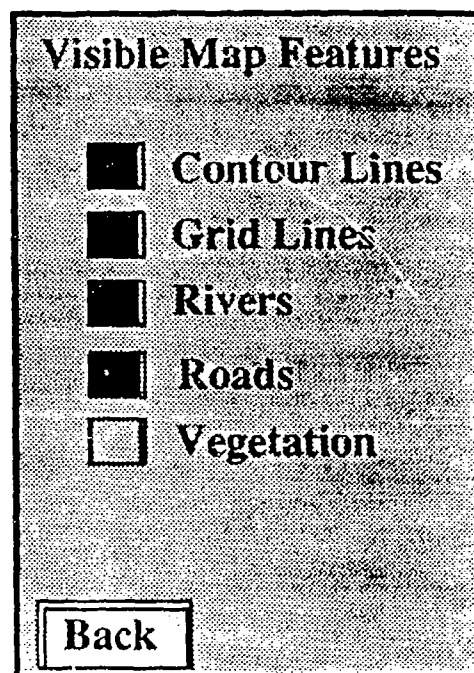
Scale ☐ 1: 25,000
☒ 1: 50,000
☐ 1: 125,000
☐ 1: 250,000

☐ Move Vehicle

Overlays **Posted Icons**

Exit **Agg** **Features**

Figure 38. Map Functions screen.



Visible Map Features

☒ Contour Lines
☒ Grid Lines
☒ Rivers
☒ Roads
☐ Vegetation

Back

Figure 39. Visible Map Features screen.

Delete Posted Icons Screen

The Delete Posted Icons screen, shown in Figure 40, enables the commander to delete report icons posted to the tactical map. Only icons posted automatically (i.e., Contact and Intelligence report icons) or manually (POST TO MAP activation from a Report Action screen) can be deleted with this screen. The commander accesses this screen by selecting **Posted Icons** from the Map Functions screen.

From the Delete Posted Icons screen, the commander can select any report icon visible on the tactical map. If it is a posted icon, a white box enclosure indicates it is selected for deletion. If the icon selected is not a posted icon, the system provides a status prompt ("Receive icon was selected"). This prompt indicates the icon is not available for deletion but its report can be accessed from the Received Messages screen.

The Delete Posted Icons screen has two fields and two menu-manipulation functions. The Select By Pointing field allows the commander to select posted icons individually on the tactical map. The Select By Age field includes five time options (Appendix B). Selecting a time option causes all icons posted earlier than the time selected to appear in white boxes. Selecting the Reset option cancels any selections made and removes the white boxes on all icons previously selected.

When selecting individual icons, multiple selections can be made for simultaneous deletion. Selection by age overrides individual icon selection. That is, if icons are selected individually and then selected by age, only deletion by age occurs. To return to the individual selection mode, the commander selects Reset which clears all highlighted icons.

The two menu-manipulation functions are BACK and DELETE. BACK returns the Map Functions screen. DELETE removes all selected icons from the tactical map and retains the Delete Posted Icons screen.

Aggregate Functions Screen

The purpose of the Aggregate Functions screen is to allow the commander to display POSNAV-generated friendly unit icons, except for own-vehicle icon, at either individual or unit level. The commander accesses the Aggregate Functions screen, shown in Figure 41, by selecting Agg from the Map Functions screen.

The Aggregate Functions screen has one field and one menu-manipulation function. The four options for the Aggregate field are Battalion, Company, Platoon, and Vehicle. Any option is available for selection except the current level of aggregation which is grayed-out. EXIT returns the Map Functions screen.

To aggregate or deaggregate friendly icons, the commander must first select a friendly vehicle or unit icon and then the desired aggregate level for displaying the friendly units. The CCD then calculates center of mass (COM) for all selected units and displays them on the tactical map. For example, if Company is selected, the CCD calculates COM for all vehicles within each of the battalion's four companies. Four company-level icons along with their unit designations are then displayed on the tactical map at the four company COM locations calculated.

Anticipated Modifications to the Command and Control Display

As the CVCC research and development program continues, the CCD will be modified in an attempt to better meet the user-based requirements identified during CVCC evaluations. The CCD modifications currently anticipated are based on the user requirements documented during prior CVCC evaluations (Ainslie et al. 1991; O'Brien et al. 1992). Resources permitting, these anticipated modifications will be made before conduct of the CVCC formal battalion evaluation.

These anticipated modifications also illustrate the iterative test and refine approach of the CVCC program. Their inclusion here may clarify the type of user-based requirements identified during CVCC evaluations and the user's impact on CCD design. The modifications anticipated are summarized in Table 3.

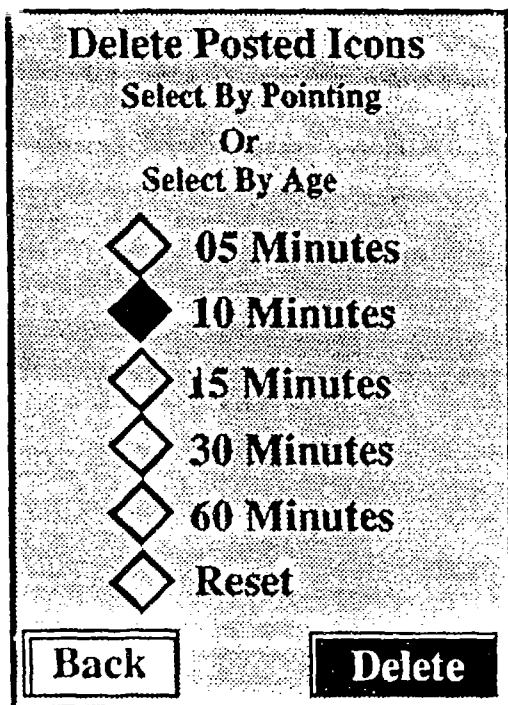


Figure 40. Delete Posted Icons screen.

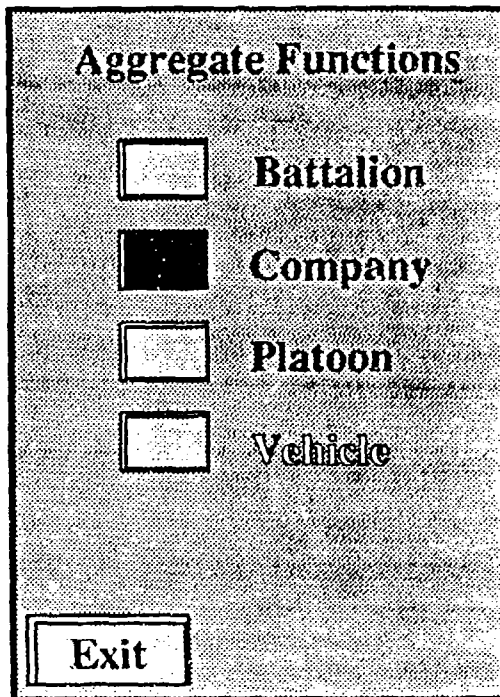


Figure 41. Aggregate Functions screen.

Selected examples from each category are briefly described, pending implementation.

Seeing the Battlefield

One of the primary goals of CVCC is to specify a system that enables vehicle and unit commanders to "see the battlefield" by enhancing their awareness and assessment of the battlefield situation. The CCD's report icons are considered central to this objective. Prior candidate CVCC systems were designed to provide immediate graphic depiction of reported information including unit type, alignment (enemy or friendly), and location on the tactical map. Commanders may perceive changes in the battlefield situation based only on this graphic information. If so, this change in perception might modify their assessment of the situation, inform subsequent decision-making, and alter their course of action.

In an effort to enrich the CCD's battlefield depiction, a modification to CVCC software will append unit size information to the report icon. The menu-based input from the preformatted report Number fields will appear adjacent the report's icon to indicate the number of reported vehicles or troops. Since front-line commanders are trained to provide accurate counts rather than estimates (platoon, company etc.), a numeric entry is required. TOC-based CVCC stations will retain their ability to

Table 3

Anticipated Modifications to the Command and Control Display

Seeing the Battlefield

- Append enemy unit size to report icons
- Extend icon retrieval to stored reports
- Extend flash for received report icons to 10 seconds
- Provide NATO standard symbols for all graphic formats
- Combine overlay and text message formats (FRAGO, OPORD)
- Rescale all tactical map graphics

Reducing Commander's Workload

- Transfer software to more powerful computer
- Monitor fuel, equipment, ammunition, and personnel
- Transmit operational effectiveness status automatically
- Eliminate duplicate messages in Old Files
- Provide alternate net default routes for relayed messages
- Provide sender and originator identifiers on all messages

Improving Soldier-Machine-Interface

- Provide "soft" numeric keypad as required
- Provide option to delete "all" report icons
- Provide delete option for overlay messages
- Provide commander feedback on distance to waypoint
- Enhance user prompts (e.g., "First select a message")
- Provide page-structured queues with enhanced prompts
- Enhance message status indicators

provide standard echelon-level symbols in their reports and overlays.

Reducing Commander's Workload

Another primary CVCC objective is specification of a system that reduces the commander's workload. Numerous instances of anticipated workload reduction for the commander were cited in the above description of version 6.12 software. For example, the automatic transfer of messages to Old Files may help commanders defer the processing of some reports until a later time. Similarly, the override capability allows commanders to access any CCD function without saving current inputs or exiting current functions. As noted, trade-offs associated with CCD workload are a concern of the CVCC program (Morey, Wigginton & O'Brien, 1992).

One way to improve CCD capabilities is to reduce the system's processing time. Future versions of CCD software will be transferred from a MARS COMP 5600 to a Sun SPARC station IPX.

Map rescale times (10- to 20-second updates under MASSCOMP), for example, may be reduced to several seconds. Overall, a faster system should encourage commanders to rely more heavily on the CCD for the functions it was designed to perform.

A central concern of battlefield commanders is their unit's readiness for continued operations. A major CCD modification will automatically provide vehicle and unit status in digital and graphic (bar chart) format for critical combat resources of fuel, ammunition, personnel, and equipment. In addition, the CCD will exploit the autorelay capability of SINCGARS coupled with the RIU to transmit this information automatically in a timely manner to both vehicle and TOC CVCC-equipped personnel.

Improving Soldier-Machine Interface

The user-based modifications for improving the CCD's soldier-machine-interface, in Table 3, are relatively direct applications of selected guidelines for designing computer interfaces (e.g., Muckler, 1984). For example, version 6.12 limitations due to the lack of a numeric keypad were noted. When numeric entry is required, a "soft" numeric keypad will be provided in the Variable Menu window to enable more precise report inputs.

Modified delete options may allow commanders to efficiently manage and dispose of information, particularly graphic data. The scroll arrows for displaying additional message and route headers will be replaced by page-structured queues that commanders can "page" through with NEXT and BACK keys. A count of message headers available in each queue and on each page of a queue will also be included. Message headers for all report types, not just Overlay reports, will include status indicators for messages relayed and posted.

Conclusion

The Army requirement for vehicle-based, automated command and control systems is accelerating. Current developmental efforts in the CCTB, for example, include extension of such systems to other combined arms elements to synchronize the battlefield digitally. To support such efforts in a timely manner, this product provides a current description of an automated command and control display developed under the CVCC program. Anticipated modifications to the CCD are included in this product to provide a more complete description of the system evolving from CVCC's programmatic effort. A more final design for tank-based automated command and control systems is anticipated upon completion of the CVCC formal battalion evaluation.

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APPENDIX A

Hierarchical Layout of the
Command and Control Display's Menu Structure

CCD REPORT RECEPTION AND RELAY

Dedicated Key
Figure Number
Menu Key

REPORTS
Figure 18
OLD

OLD FILE
Figure 11
SHOW

RECEIVE
Figure 10
SHOW

LEVEL 1



INTEL
Figure 22
PREP

AMMO
Figure 20
PREP

ADJUST
Figure 19
PREP

NBC
Figure 17
PREP

CFF
Figure 14
PREP

CONTACT
Figure 12
PREP

LEVEL 2



RELAY
Figure 13/21
SEND

LEVEL 3

CCD REPORT RECEPTION AND RELAY (CONTINUED)

Dedicated Key
Figure Number
Menu Key

REPORTS
Figure 18
OLD

OLD FILE
Figure 11
SHOW

RECEIVE
Figure 10
SHOW

LEVEL 1



OVERLAY
Figure 34
PREP

FREE TEXT
Figure 33
PREP

SIT REP
Figure 32
PREP

SPOT
Figure 29
PREP

SHELL
Figure 26
PREP


LEVEL 2



RELAY
Figure 13/21
SEND

LEVEL 3

CCD REPORT CREATION AND RELAY


 Dedicated Key
 Figure Number
 Menu Key

LEVEL 1

REPORTS	Figure 18	NEW
---------	-----------	-----



LEVEL 1 1/2

AMMO	Figure 12	PREP
------	-----------	------

AMMO	Figure 14	PREP
------	-----------	------

ADJUST	Figure 19	PREP
--------	-----------	------

AMMO	Figure 20	PREP
------	-----------	------

SHELL	Figure 26	PREP
-------	-----------	------



LEVEL 2/3

RELAY	Figure 13/21	SEND
-------	--------------	------

CCD REPORT CREATION AND RELAY (CONTINUED)

Dedicated Key
Figure Number
Menu Key



LEVEL 1

REPORT	Figure 18	NEW
--------	-----------	-----



LEVEL 1/2

NBC	Figure 15	NEXT
-----	-----------	------

NBC (P2)	Figure 16	NEXT
----------	-----------	------

NBC (P3)	Figure 17	PREP
----------	-----------	------

INTEL (P1)	Figure 22	NEXT
------------	-----------	------

INTEL (P2)	Figure 23	NEXT
------------	-----------	------

INTEL (P3)	Figure 24	NEXT
------------	-----------	------

INTEL (P4)	Figure 25	PREP
------------	-----------	------

SPOT (P1)	Figure 29	NEXT
-----------	-----------	------

SPOT (P2)	Figure 30	NEXT
-----------	-----------	------

SPOT (P3)	Figure 31	PREP
-----------	-----------	------

SIT REP (P1)	Figure 30	NEXT
--------------	-----------	------

SIT REP (P2)	Figure 31	NEXT
--------------	-----------	------

SIT REP (P3)	Figure 32	PREP
--------------	-----------	------



LEVEL 2/3

RELAY	Figure 13/21	SEND
-------	--------------	------

CCD NAVIGATION AND MAP MANIPULATION

Dedicated Key
Figure Number
Menu Key

MAP
Figure 38
EXIT

COLL OUT
Figure 37
COLL IN

NAV
Figure 35
FILES

LEVEL 1



AGG
Figure 41
EXIT

POSTED ICONS
Figure 40
DELETE

FEATURES
Figure 39
BACK

OVERLAYS
Figure 34
PREP



RELAY
Figure 21
SEND



ROUTE FILES
Figure 36
PREP



RELAY
Figure 21
SEND

LEVEL 2

LEVEL 3

APPENDIX B

Data Elements for the Command and Control Display

APPENDIX B

DATA ELEMENTS FOR THE COMMAND AND CONTROL DISPLAY

Field and Option Data Elements for Commander's Input to the Command and Control Display (see Glossary for elements not defined)

<u>Input Field</u>	<u>Input Options</u>
Activity (unit)	Gnd Atk, Air Atk, Fire, Defend, Delay, Recon.
Aggregate	Battalion, Company, Platoon, Vehicle (level friendly icon depiction).
As Of	Now, -5, -10, -15, -30, -45 (minutes).
Atk Loc	Six-digit coordinate and map prefix.
Attack (type)	Nuclear, Biological, Chemical (agent).
Auto Adv	Activate automatic waypoint advance (for Steer-To-Indicator).
Burst (type)	Air, Surface (NBC report).
Cdr Intent (Commander)	No Change, Attack, Defend, Delay, Withdraw.
Contour Lines	Add or remove this map feature.
Crit. Short (Critical)	Pers., Ammo, Fuel, Equip (status).
Dest (destroyed enemy)	1, 2, 3, 5, 7, 10, 20, 30, 40, 50, 60, 75, 100 (elements).
Enemy Act (intensity)	Light, Medium, Heavy.
EOM (End Of Miss)	Include as appropriate.
Flash/Bang Time	n/a, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 16, and 18 (seconds).
Forward To	Select radio net for transmission (based on duty position).
Free Text	No input options on Command Control Display.
FFE (Fire For Effect)	Include as appropriate.

Grid Lines	Add or remove this map feature.
Hdg (Heading)	Select map location for three-digit value (0-360 degrees).
Heat (rounds)	Green, Amber, Red, Black (status).
Move Vehicle	Any location on map data base (six-digit resolution).
None (driver)	Activate no waypoint (for STI).
Nuc Cloud Ht (deg)	n/a, 1, 2, 3, 4, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50 (degrees).
Nuc Cloud Wid (deg)	n/a, 1, 2, 3, 4, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50 (degrees).
Nuc Crsr Diam (m)	n/a, 50, 100, 150, 200, 250, 300, 350, 400, 450 (meters).
Number (enemy)	1, 2, 3, 4, 5, 7, 10, 20, 30, 40, 50, 60, 100 (elements).
Number (Shell report)	1, 2, 3, 4, 5, 7, 10, 15, 20, 30, 40, 50, 60, 75, 100 (shells).
Number Shells (NBC)	n/a, 1, 2, 3, 4, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50 (shells).
Obs (observed enemy)	1, 2, 3, 4, 5, 7, 10, 20, 30, 40, 50, 60, 75, 100 (elements).
Obs Loc (observer)	Six-digit coordinate and map prefix.
Own Act	End Atk, Air Atk, Fire, Defend, Delay, Recon.
Rivers	Add or remove this map feature.
Roads	Add or remove this map feature.
Sabot (rounds)	Green, Amber, Red, Black (status).
Select By Age	5, 10, 15, 30, 60 minutes, Reset (for deletion of posted icons).
Select By Pointing	Select posted icons on tactical map for deletion.
Shift: Add/Drop (m)	0, A50, A100, A150, A200, D50, D100, D150, D200 (for adjusting indirect fire).

Shift: Left/Right (m)	0, L50, L100, L150, L200, R50, R100, R150, R200 (for adjusting indirect fire).
Smoke	Green, Amber, Red, Black (status).
Stored Route Headers	Select a route for review.
Target (location)	Six-digit coordinate and map prefix.
Vegetation	Add or remove this map feature (not available at 1:125,000 and 1:250,000).
Waypoint (Commander)	Six-digit coordinate with map prefix.
Waypoint (Driver)	Select individual waypoint (for Steer-To-Indicator).
What (enemy)	Tank, Helo, FW Air, Arty, Truck, Troops, ATGM, PC.
What (friendly)	Arty, C2, Mech, Mortars, Scout, Supp, Tank.
What (obstacle)	Abati, Blown Bridge, Minefield, Tank Ditch.
Where (obstacle)	Pair of six-digit coordinates with map prefixes.
Where (FLOT)	Pair of six-digit coordinates with map prefixes.
.50 CAL (rounds)	Green, Amber, Red, Black (status).
7.62 mm (rounds)	Green, Amber, Red, Black (status).

APPENDIX C

Glossary of Acronyms and Abbreviations

APPENDIX C

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

Act	Activity
ADJUST	Adjust (indirect fires)
Agg	Aggregate Function
Air Atk	Air Attack
AMMO, A	Ammunition
ARI	Army Research Institute
Arty	Artillery
ATCCS	Army Tactical Command and Control Systems
ATGM	Anti-Tank Guided Missile
Atk Loc	Attack Location
Auto Adv	Automatic Advance (waypoint updates)
C ² , C2	Command and Control
CAL	Caliber
CCD	Command and Control Display
CCTB	Close Combat Test Bed
Cdr Intent	Commander's Intent
CFF	Call For Fire
CITV	Commander's Independent Thermal Viewer
CLP FLD	Clear Field
COM	Center Of Mass
Crit. Short	Critical Shortage(s)
CRT	Cathode Ray Tube
CVCC	Combat Vehicle Command and Control
DCD	Directorate of Combat Developments
Dest	Destroyed
EOM	End Of Mission (indirect fires)
Equip, E	Equipment
F	Fuel
FFE	Fire For Effect (indirect fires)
FLOT	Forward Line of Own Troops
FRAGO	Fragmentary Order
FW Air	Fixed Wing Aircraft
GARB	Green, Amber, Red, Black (status)
Gnd Atk	Ground Attack
Hdg	Heading
Helo	Helicopter
Intel	Intelligence
IVIS	Intervehicular Information System
Log	Logistics
LRF	Laser Range Finder
Mech	Mechanized
mm	millimeter
MOA	Memorandum Of Agreement
MOPP	Mission Oriented Protective Posture
n/a	not available
NATO	North Atlantic Treaty Organization
NAV	Navigation
NBC	Nuclear, Biological, Chemical
Nuc Cloud Ht	Nuclear Cloud Height

Nuc Cloud Wid
Nuc Crtr Diam
Obs
Obs Loc
OPORD
O/T
PC
Pers, P
POSNAV
PREP
Recon
RIU
SIMNET
SINGARS
SITREP
STI
Supp
TACOM
TOC
USAARMC
UTM
WP, W#

Nuclear Cloud Width
Nuclear Crater Diameter
Observed
Observer's Location
Operations Order
Observer/Target (line, indirect fires)
Personnel Carrier
Personnel
Position Navigation
Prepare (report)
Reconnaissance
Radio Interface Unit
SIMulated NETworking
Single Channel Ground and Airborne Radio System
Situation Report
Steer-To-Indicator
Supply
Tank Automotive Command
Tactical Operations Center
United States Army Armor Center
Universal Transverse Mercator (grid system)
Waypoint (navigation, number)

Nuc Cloud Wid	Nuclear Cloud Width
Nuc Crtr Diam	Nuclear Crater Diameter
Obs	Observed
Obs Loc	Observer's Location
OPORD	Operations Order
O/T	Observer/Target (line, indirect fires)
PC	Personnel Carrier
Pers, P	Personnel
POSNAV	Position Navigation
PREP	Prepare (report)
Recon	Reconnaissance
RIU	Radio Interface Unit
SIMNET	SIMulated NETworking
SINGARS	Single Channel Ground and Airborne Radio System
SITREP	Situation Report
STI	Steer-To-Indicator
Supp	Supply
TACOM	Tank Automotive Command
TOC	Tactical Operations Center
USAARMC	United States Army Armor Center
UTM	Universal Transverse Mercator (grid system)
WP, W#	Waypoint (navigation, number)